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INSTRUCTION MANUAL 22-60Ja
for
STABILIZED DIELECTRIC TEST SET
BIDDLE CATALOG NO. 222060

BIDDLE
INSTRUMENTS

JAMES G. BIDDLE CO.

INSTRUCTION MANUAL 22-60Ja
for
STABILIZED DIELECTRIC TEST SET
BIDDLE CATALOG NO. 222060

HIGH VOLTAGE EQUIPMENT

PLEASE READ CAREFULLY
BEFORE OPERATING

Safety is the responsibility of the user

APARATO DE VOLTAJE ALTO

SIRVANSE LEER ESTE LIBRO CON CUIDADO
ANTES DE OPERARLO

La seguridad es responsabilidad del operador

JAMES G. BIDDLE CO.
Plymouth Meeting, Pa. 19462

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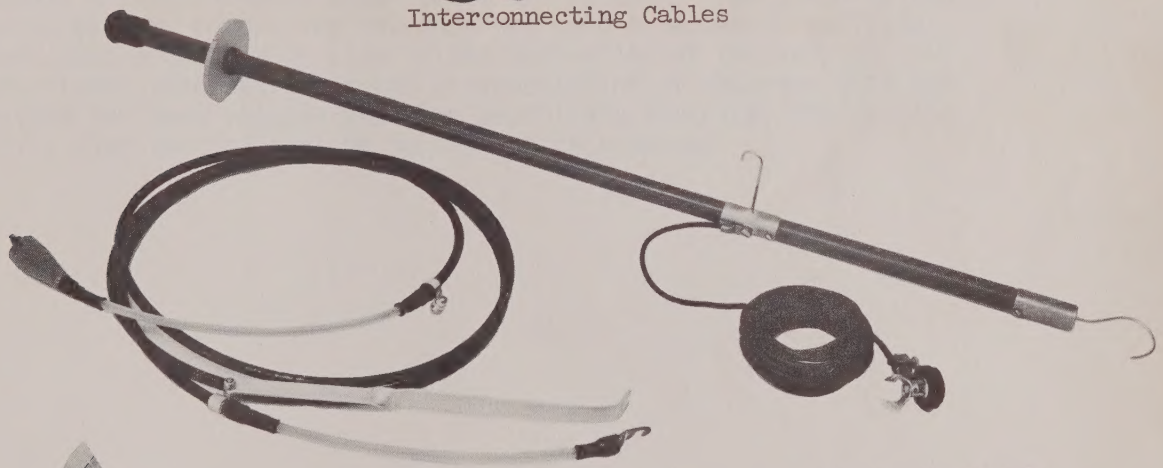
Control Unit

High Voltage Unit

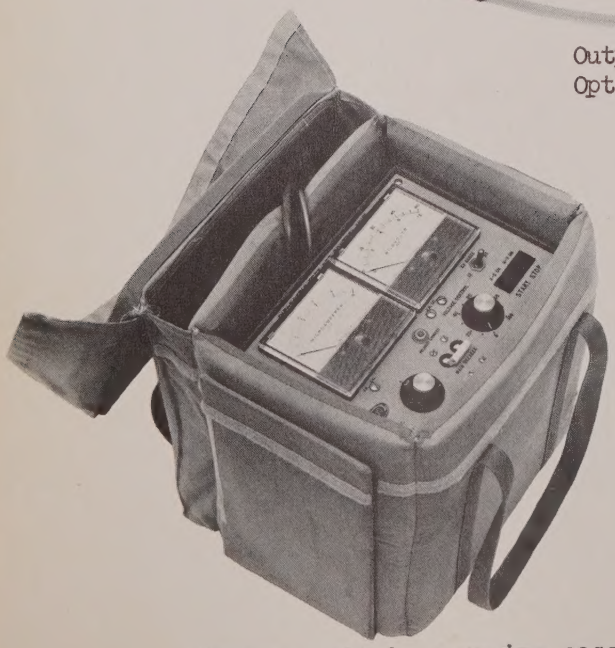
Interconnecting Cables



Output Cable,
Option Cat. No. 222060-60

Discharge Stick
Option Cat. No. 22260-62

ACCESSORIES



Control unit in carrying case

FIGURE 1:

SECTION A

INTRODUCTION

This Instruction Manual is intended as a guide to the operation and maintenance of the Biddle portable, stabilized Dielectric Test Set, Cat. No. 222060.

The instructions and suggestions of this manual anticipate the normal use of the Dielectric Test for dc proof tests of electrical insulation in such equipment as motors, generators, bushings, and cables; and the measurement of leakage and absorption currents. Such tests are able to provide important guides as to the condition of a given electrical insulation system and are based on observation of the applied voltage, the resultant current flow and the manner that current varies with time. Very often this information is plotted on graph paper such as Biddle Kilovolt-Megohm paper (Cat. No. 220000). The shape of the curve made by connecting the observed points becomes significant. Such data presentation aids in the evaluation of the sample. For additional information on the interpretation of observed data and guides for test voltage and time see Biddle Technical Publication 22T1, also the Application Section of this manual.

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SECTION C

SPECIFICATIONS

Maximum Output Voltage:	60 kV dc.
Maximum Output Current:	5mA for 15 minutes, 3mA continuous.
Output Polarity:	Negative with respect to ground.
Supply Voltage:	105-125 volts, 50/60 Hz, single phase, grounded.
Max. Supply Current (normal operation):	9 amperes.
Ripple, full load (resistive):	2% RMS.
Time to charge capacitive sample to 98%:	42 seconds/0.1 microfarad.
Time to discharge to 2% (through internal resistance):	1.3 minutes/0.1 microfarad.
Regulation:	Less than 1% for all loads up to 3 mA.
	Less than 3% for all loads up to 5 mA.
Voltmeter:	4 1/2" taut band, 2 ranges: 0-12 and 0-60 kV.
Current Meter:	4 1/2" taut band, 5 ranges: 0-5/50/500 μA, 5/50 mA.
Meter Accuracy:	±2% of full scale.
Overload Protection:	Magnetic circuit breaker in input line.
	Separate fuses for auxiliary power supply and fan.
	Crowbar circuit on the main rectifier supply tripped by line voltage in excess of 130 V or by sample short-circuit.
	Voltmeter and Current Meter internally protected.
	High voltage ballast resistor to limit ground-loop currents so that control unit remains essentially at ground potential in the event of sample failure, when properly connected.
Control Circuit:	Pushbutton start and stop sequence, zero start interlock
	Input line ground indicated by pilot lamp.
	Rate-of-rise automatically limited and independent of control knob manipulation.
	Jack provided for external current meter.

Overall Size and Weight:

Control Unit: 11 x 12 x 8½" (28.0 x 30.5 x 21.6 cm); 25 lbs. (11.3 kg).

HV Unit: 16½ x 12½ x 5½: (42 x 31.7 x 14 cm); 22 lbs. (9.9 kg).

SECTION D

DESCRIPTION

The equipment is a stabilized dielectric test set for use in the field, shop or laboratory for measuring the electrical quantities of applied voltage and current flowing in samples to which it is connected. Because it incorporates a stabilizing arrangement, measurement of variations in current with time are simplified. The set is very lightweight equipment for convenient transportation and is constructed in two units.

Circuit operation is as follows: (Refer to the block diagram Figure 2, Page D3). The relationship between the block diagram and the schematic (Figure 3, Page D4), will be evident since the component symbols on the schematic have similar numbers on the block diagram.

The basic power line control system is block (1) and controls the three power supplies (400).

The circuit action is controlled by feedback loops. Starting from the oscillator (201) a sawtooth wave of about 17.2 KHz is generated. In the error-signal-pulse-width logic (202) this is converted into two identical square wave trains of constant amplitude and opposite polarities having a frequency of about 8.6 KHz. These two wave trains are summed to form a complete square-wave.

The voltage control (601) acts on the pulse-width logic (202) to change the length of the ON period of both wave trains to effect control. This action can be followed starting with one wave train at the zero condition: after a time T_1 the wave steps to its maximum amplitude and remains at this level for a period of time T_2 when it returns to zero. In this way a waveform is obtained (as shown in Fig. 2) at the pulse shaper (203). Time T_1 has a fixed minimum value of about 8 micro-seconds and the logic varies the time T_1 and T_2 under the action of the voltage control in such a way that Equation 1 always applies.

Equation 1:

$$8.6 \text{ KHZ} = \frac{1}{4T_1 + 2T_2}$$

The output of the pulse shaper feeds the drive amplifier (204) which reproduces in amplified form the basic waveform (See Figure 2, Waveform inset, Page D3). This drive signal is used to control a transistor bridge switch (main power converter 300) that applies the dc from power supply (403) to the high voltage transformer primary included in block 500. The secondary voltage is rectified and multiplied by a factor of 4 to produce the output voltage. Control is effected by varying T_2 from zero to the limit as previously explained.

The voltmeter (100) measures the actual output voltage and provides a signal to the error amplifier (602) that compares the setting of the voltage control with the actual output. If an error exists because the output is low, a signal is fed to the logic to increase T_2. When no error exists T_2 tends to become zero or remains just sifficient to hold the desired output voltage to the value set on the voltage control, regardless of line voltage variations or variations in the current flowing in the sample.

DESCRIPTION

To limit the output current to the capabilities of circuit components it is necessary to provide an automatic limit to the growth rate of T_2 when setting the voltage control. This is provided by the slew rate circuitry of (601).

The current meter (100) measures only the current flowing in the sample. In the event of overcurrent, due to sample failure or low impedance, the overcurrent trigger of block (300) trips the crowbar and very rapidly shuts the test set down to prevent internal damage and to limit sample damage.

As a protection against overvoltage surges in the main power supply the voltage trigger will shut the set down via the crowbar.

The high operating frequency reduces the internal stored energy and close control is possible because regulation is on a per cycle basis.

The heavy current solid state devices are cooled by a fan that comes on before these components are energized and remains on after they are shut down. In the event of fan failure or blockage of the ventilation the thermal switches act to shut the set down. The remainder of the control circuit is conventional which is evident from the schematic.

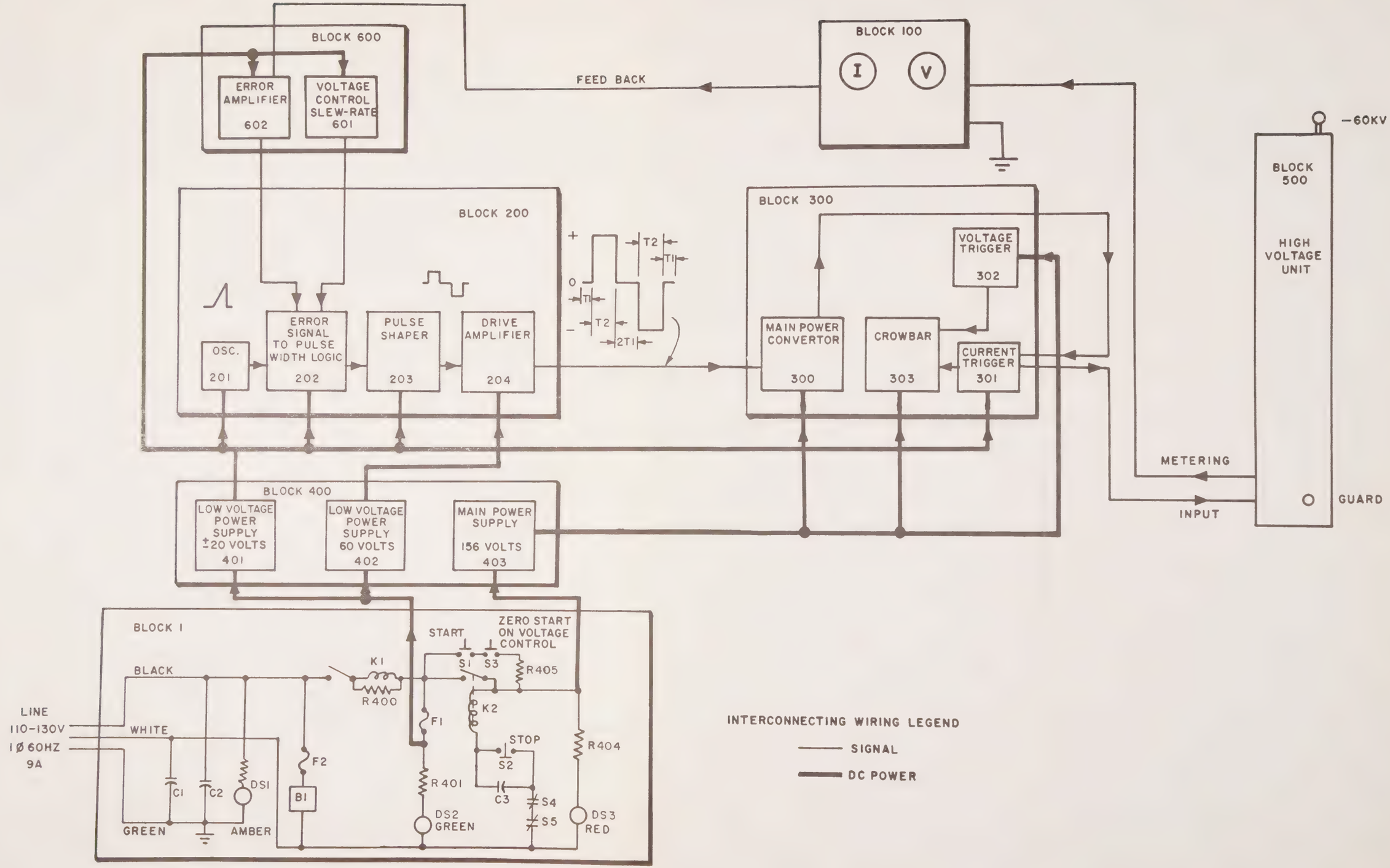
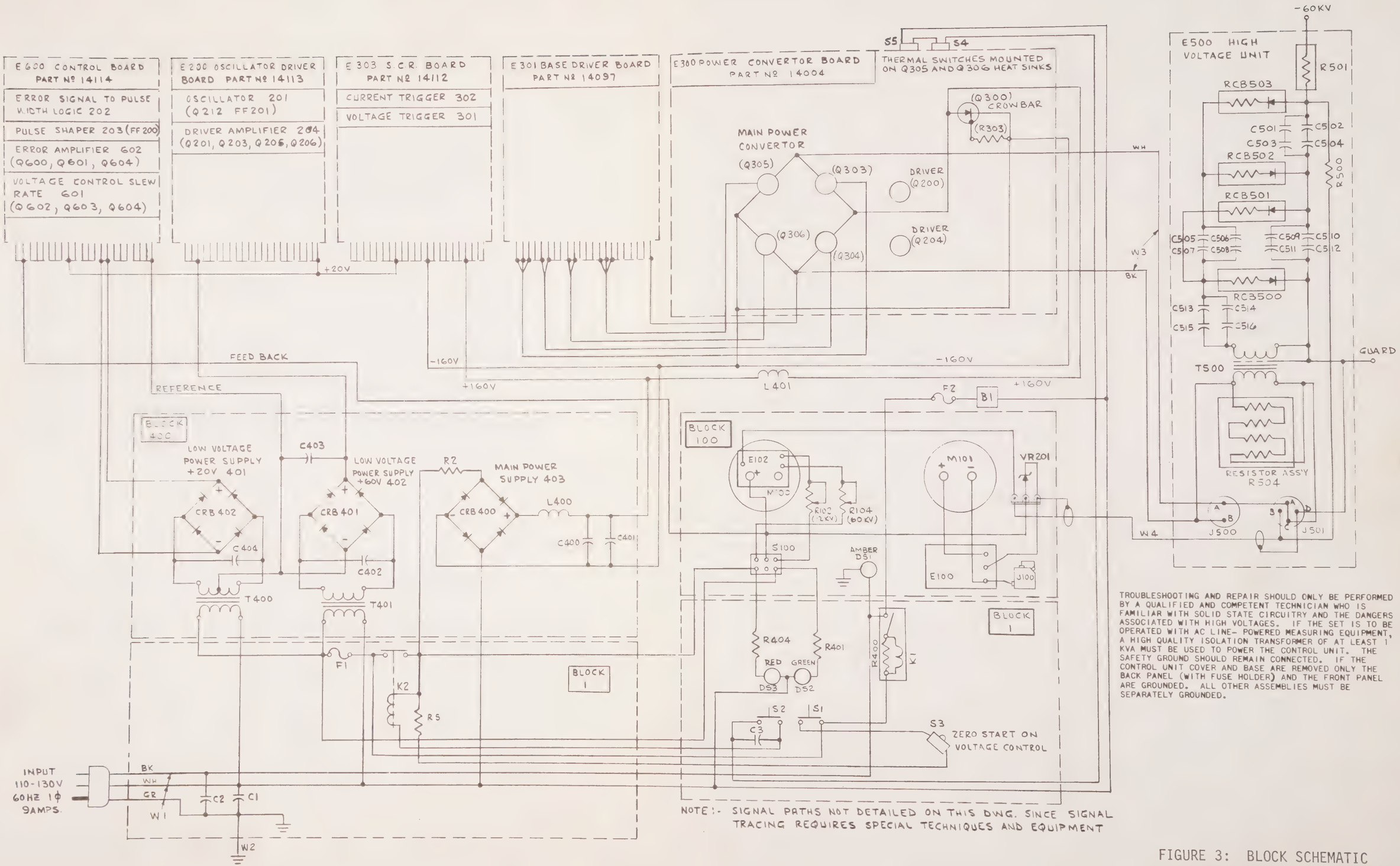


FIGURE 2: BLOCK DIAGRAM (WAVEFORMS)



NOTE:- SIGNAL PATHS NOT DETAILED ON THIS DWG. SINCE SIGNAL TRACING REQUIRES SPECIAL TECHNIQUES AND EQUIPMENT

TROUBLESHOOTING AND REPAIR SHOULD ONLY BE PERFORMED BY A QUALIFIED AND COMPETENT TECHNICIAN WHO IS FAMILIAR WITH SOLID STATE CIRCUITRY AND THE DANGERS ASSOCIATED WITH HIGH VOLTAGES. IF THE SET IS TO BE OPERATED WITH AC LINE- POWERED MEASURING EQUIPMENT, A HIGH QUALITY ISOLATION TRANSFORMER OF AT LEAST 1 KVA MUST BE USED TO POWER THE CONTROL UNIT. THE SAFETY GROUND SHOULD REMAIN CONNECTED. IF THE CONTROL UNIT COVER AND BASE ARE REMOVED ONLY THE BACK PANEL (WITH FUSE HOLDER) AND THE FRONT PANEL ARE GROUNDED. ALL OTHER ASSEMBLIES MUST BE SEPARATELY GROUNDED.

FIGURE 3: BLOCK SCHEMATIC

SECTION E

SETTING UP

Refer to Figure 4, Page E3, and Figure 5, Page E4 for location of operating controls and cables.

Refer to Figure 6, page E5 for representative connection of the set to typical samples.

Insure that the sample is in a safe condition and that the area is protected from intrusion by unauthorized persons. Position the High Voltage Unit so the top ball terminal can be readily connected to the high voltage terminal of the sample (do not connect at this time). The low voltage end of the sample is to be connected to ground.

As a guide in setting up a test, the minimum air clearances given in Table I must be maintained[1] between the exposed energized conductor and any adjacent grounds in order to prevent arc-over. Such accidental arc-over may damage a sample or cause a safety hazard. The clearance values shown apply to the direct air path at the point of closest proximity to ground.

The position of the exposed conductors with respect to ground can often be conveniently established by using clean nylon rope to tie the conductor in place. Table I indicates proper lengths for such rope if it is connected to any high voltage conductor. Note that a leakage current which flows down the rope will be included in the total current measured by the Test Set unless guarded. If the rope is tied to the cable shield, lengths are not critical, provided they do not intrude into the direct air path.

TABLE I: Air Clearances, High Voltage to Ground.
(These are inadequate for personnel safety clearance)

Voltage of Test	Direct Air Path	Path Along Dry Nylon Rope
5 kV	1 1/4 inches	1 inch
10 kV	1 9/16 inches	2 1/4 inches
15 kV	1 7/8 inches	3 1/2 inches
20 kV	2 1/4 inches	5 inches
30 kV	2 7/8 inches	7 1/2 inches
40 kV	3 1/2 inches	10 inches
50 kV	4 1/4 inches	13 inches
60 kV	5 inches	16 inches

[1] See Operation Notes (Section G)

SETTING UP

Note that test set sensitivity is such that even the nylon carrying strap of the high voltage unit will cause a current reading if it is touching the high voltage terminal. If the output terminal ball is not screwed down tightly it will often cause a false leakage reading to occur due to corona.

Locate the control unit in a safe position within 10 feet of the High Voltage Unit and interconnect it to the High Voltage Unit. The position chosen must be within ground cable reach (10 feet) of a low resistance ground. Make the ground connection. The input cable must also reach (10 feet) a 120 V service outlet, preferably of the standard 3-wire form.

Provide cover to protect both units from rain and avoid locating on very wet surfaces.

NOTE: Before Energizing the Test Set to Conduct Tests, Read and Understand the Safety Precautions of Section B, and Operating and Application Instructions of Sections F, G, and H.

Set Up Summary:

A. Select Test Connection Method.

B. Review for Safety.

C. Check Clearances and Potential Corona or Other Leakage Sources.

D. See Section F for Operating Information.

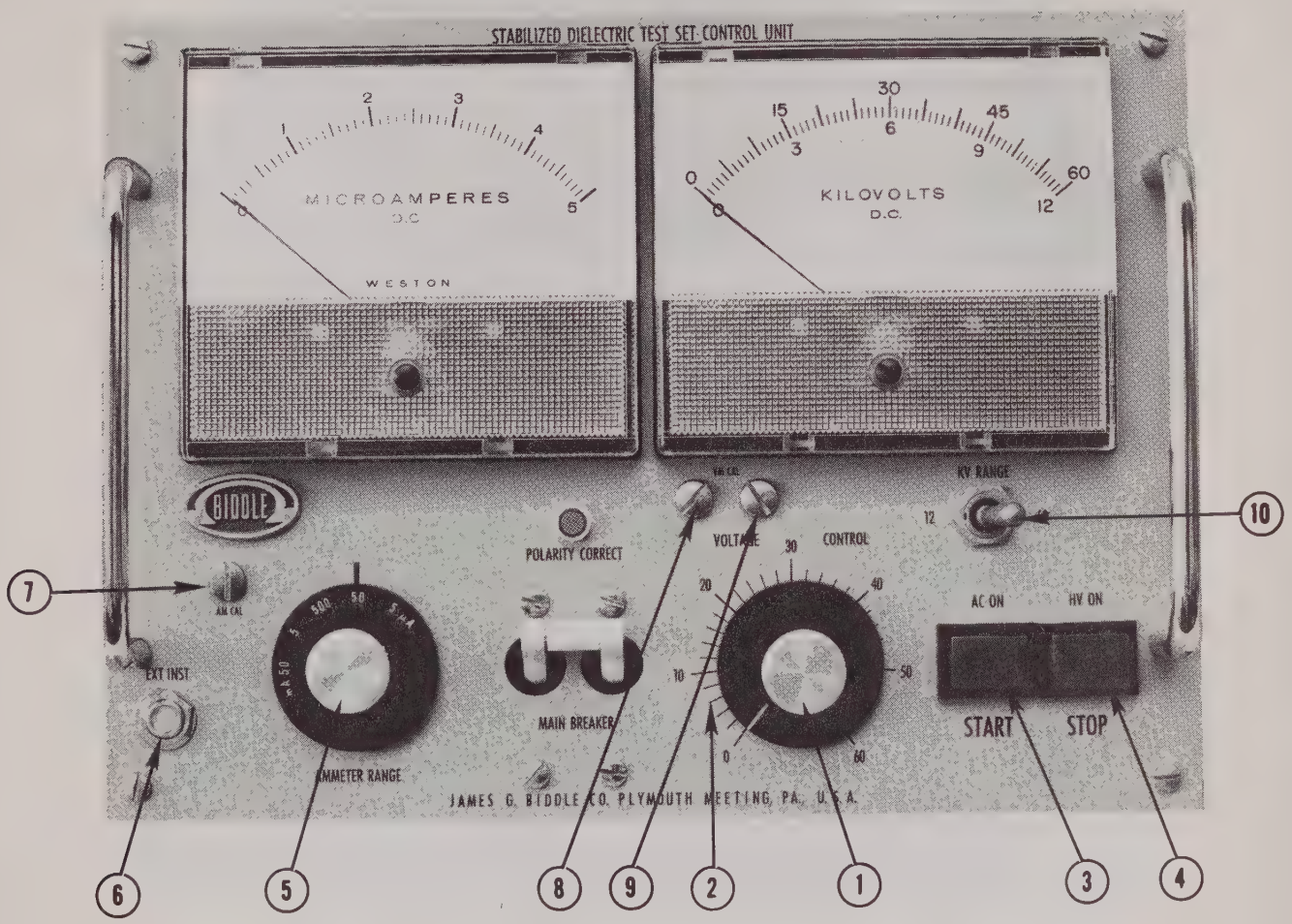


FIGURE 4: FRONT PANEL

1. Voltage Control (R614)
2. Voltage Setting Scale in kV
3. Start Button (Green Lamp) (S1)
4. Stop Button (Red Lamp) (S2)
5. Current Meter Range Switch (E100)
6. External Instrument Jack (J100)
7. Cover Screw - Current Meter Calibration (R1)
8. Cover Screw - 12 kV Voltmeter Calibration (R101)
9. Cover Screw - 60 kV Voltmeter Calibration (R104)
10. Voltmeter Range Selector Switch (S102)

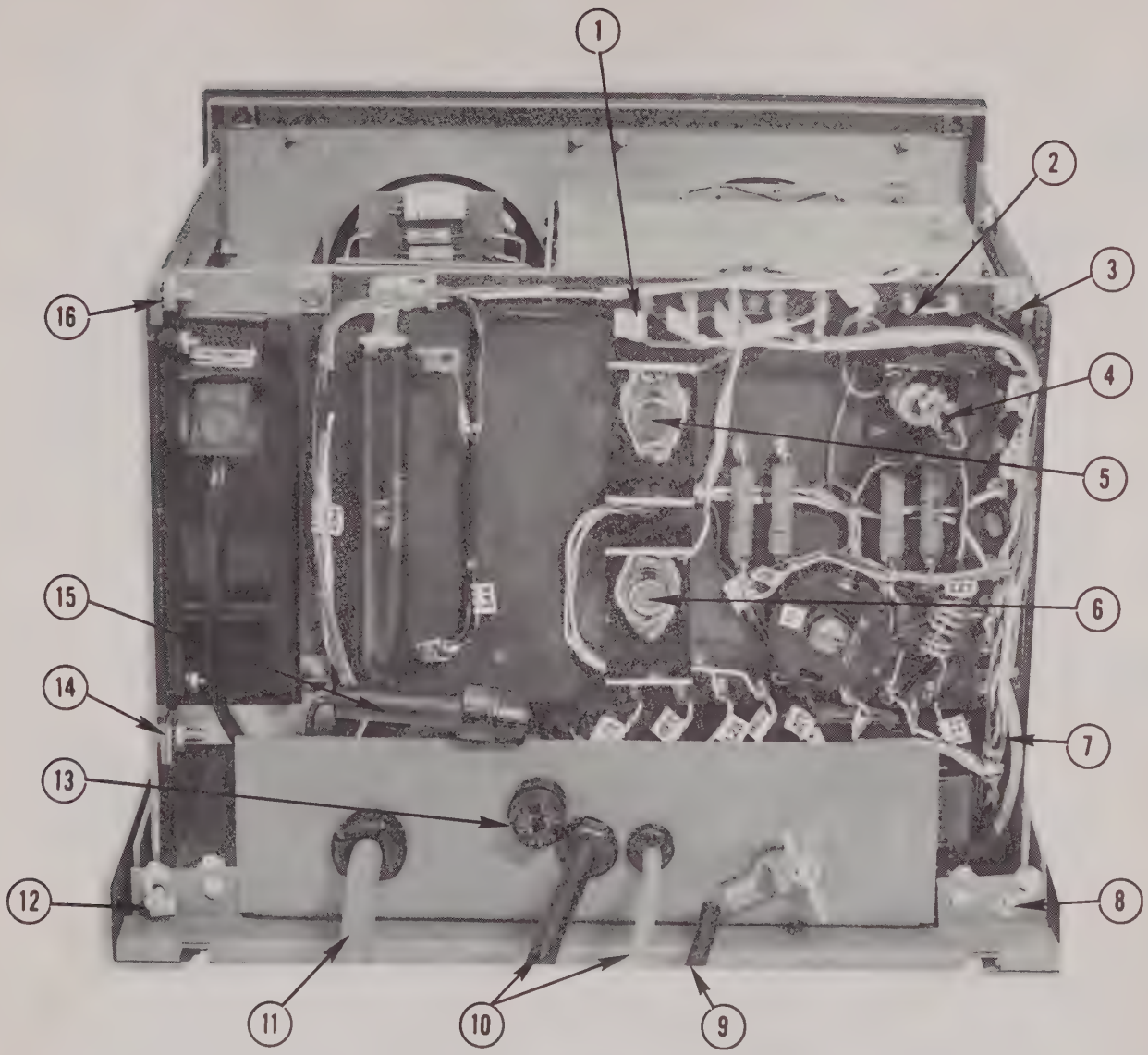


FIGURE 5: REAR VIEW

1. Red Lead to Test Driver Circuit
2. Main Power Converter Test Link
3. Main Circuit Board Holding Screw
4. Crowbar SCR (Q300)
5. Driver Transistor (Q200)
6. Driver Transistor (Q204)
7. Main Circuit Board Holding Screw
8. Case Cover Screw
9. Ground Cable
10. Interconnecting Cables
11. Line Cord
12. Case Cover Screw
13. Fuse (F1)
14. Main Circuit Board Holding Screw
15. Fan Fuse (F2)
16. Main Circuit Board Holding Screw

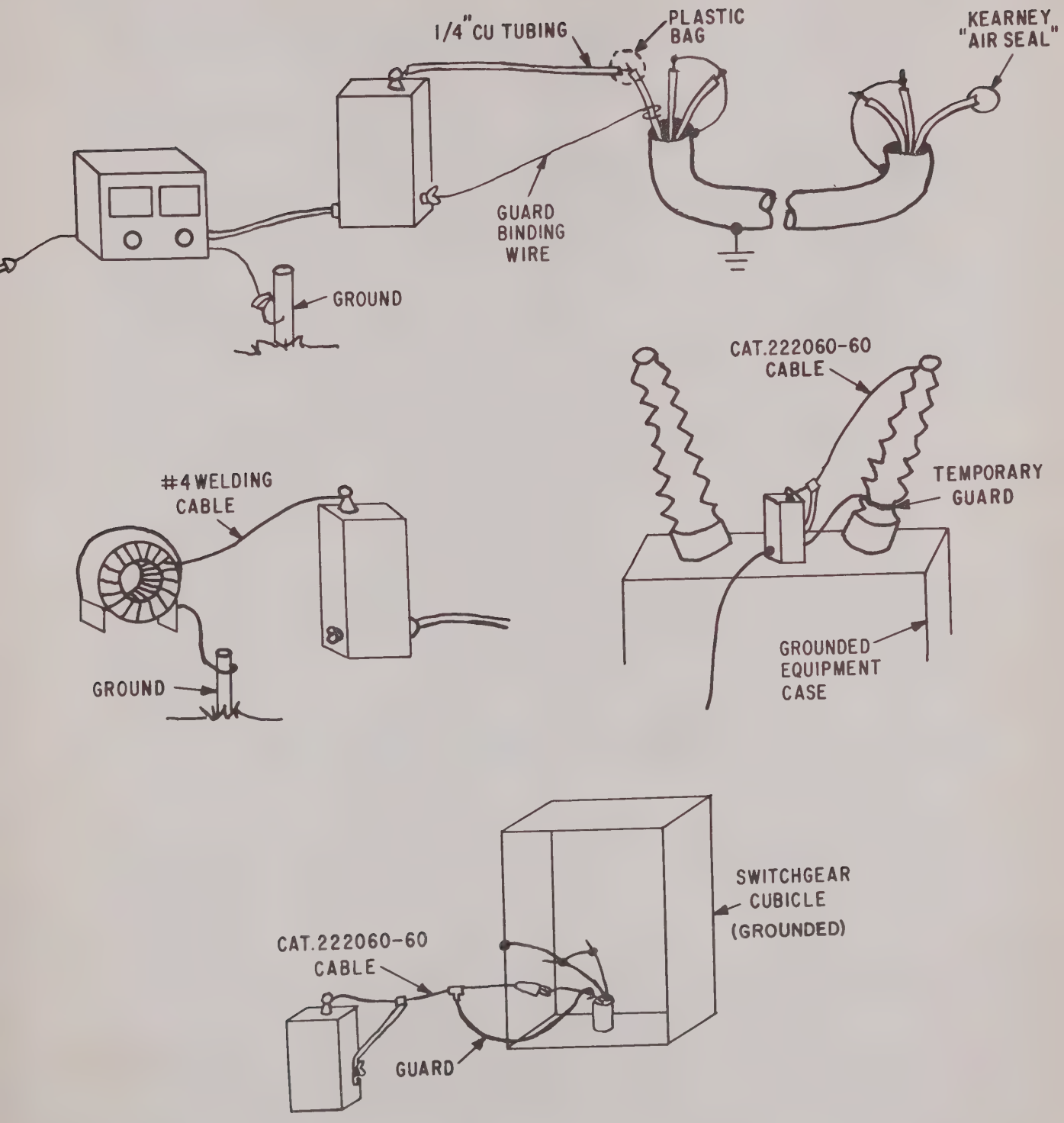


FIGURE 6: TEST CONNECTIONS TO SAMPLES

SECTION F

OPERATION

CAUTION: Become familiar with this entire manual before energizing the test set for any purpose!

NORMAL OPERATING SEQUENCE

Steps A through Q listed below form the typical normal operating sequence. Deviations from this sequence are covered in further paragraphs of this section. SECTION G contains certain explanatory material on Steps A, F and G. SECTION H entitled "Application Notes" provides additional information needed to use the set.

The normal operating steps are as follows:

A. Clear all personnel from testing area. Check all safety precautions; review SECTIONS B and F of this manual.

B. Observe that the polarity lamp glows at normal brilliance and fan runs with circuit breaker "OFF" (down); connect line cord.

C. Close circuit breaker; green light goes on.

D. Set and hold VOLTAGE CONTROL at zero.

E. Press START button; red light goes on. If in two or three seconds the red light does not go on, release the "START" button. To prevent damage, wait five minutes and try again. This condition can result from low line voltage; other causes require service.

F. Set current meter to 50 mA range.[1]

G. Raise output voltage to desired value using the dial setting. Verify by reading voltmeter and make current measurement, selecting current meter range as required.[1]

H. Return VOLTAGE CONTROL to zero.

J. Press STOP button (red light) to put out red light and return to ready condition.

K. Open circuit breaker to put out green light. Stand by.

L. Allow voltage on set and sample to return to zero or safe value. (Voltage may be lowered quickly by use of optional discharge resistance "Hot Stick", Cat. No. 222060-62.)

M. Apply safety ground (short-circuit) to sample under test and observe that voltmeter reads zero.

N. Remove line cord.

P. Disconnect set from sample.

---

[1]See Operation Notes (Section G).

Q. Remove all grounds except a permanently connected safety ground across the sample which should be left in place until all energy stored in the sample has been dissipated.

INTERRUPTING A TEST

Steps A through Q define a normal procedure that can be modified to accommodate the type of test and samples under consideration. A test can be interrupted at any time by pressing the STOP button or opening the circuit breakers or returning the VOLTAGE CONTROL to zero. This will not remove the voltage stored in the capacitance of the Test Set and sample. It is necessary to reduce this stored energy by waiting for the internal resistance of the Test Set to discharge the system or to hasten the discharge by applying a parallel resistance to ground using hot-stick techniques. To prevent transients which may damage the sample it is generally not desirable to apply a short-circuit to the system unless the voltage has been reduced to half the voltage of the test.

OVERLOAD TRIP

In the event of excessive leakage from a sample or if for any reason current is taken in excess of the rating limit of the Test Set, the circuit breaker will trip. Because of the zero-start sequence any trip-out will require that the start procedure of steps A through G be repeated to re-energize the test.

USING DISCHARGE STICK CAT. NO. 222060-62

The discharge stick contains a discharge resistor in series when contact is made to the tip of the stick. The direct grounding of a sample after discharge can be made by moving the stick so that the hook near the middle is connected to the sample. Before using the discharge stick, connect the ground cable to a low resistance ground.

USING OUTPUT CABLE CAT. NO. 222060-60

When using the output cable option, care must be taken to discharge the sample at its terminal. This is mandatory when applying the solid safety ground to insure that the sample is securely grounded (by visible ground connection) and to protect the test cable. The test cable incorporates a surge limiting resistor that is designed to protect the Test Set and cable. The cable surge resistor is not intended as a discharge resistor for the sample.

The proper safe procedure for discharging a sample when using the test cable and discharge stick options is to first shut down the Test Set, then apply the hook end of the discharge stick to the sample terminal until the voltage (as indicated on the Test Set voltmeter) is one half or less of the voltage used in the test. When this voltage level is obtained, the lower terminal of the discharge stick or a separate ground can be connected to the sample terminal to completely discharge the sample. For safety, a ground bond should then be connected across the sample terminals and left in place. (See SECTION B.)

SECTION G

OPERATION NOTES

The letter preceding each note refers to the operating instruction step in SECTION F (Operation).

(A) When the set is connected to an energized socket having one leg grounded, the polarity lamp will glow. If this does not occur either the socket is not energized or the line ground is incorrect or does not exist. This condition should be corrected.

(F) It is good practice to habitually leave the current meter range switch on the 50 mA range except when actually making a measurement.

(G) The voltage control scale can be used to repeat the output voltage setting within ±1 kV under normal circumstances. By using this feature it is not necessary to "inch" the control or to follow the indicated voltage. This feature will be found very helpful in making step voltage tests or when setting-up a test at a predetermined voltage. By following the Voltage Control scale setting, over-voltaging a sample can be avoided.

For all normal use no special care is necessary in the rate at which the voltage control is increased, but it is recommended that it be done reasonably slow to prevent any possibility of tripping the input breaker. The circuit is designed to charge samples up to 1 μfd under the automatic control of the slew-rate circuit.

The output voltage will appear to lag behind the control because of the slew-rate circuit, the extent of this lag depends on the capacitance of the sample.

The action to be expected is for the voltage to rise relatively slowly to the value set on the Voltage Control and then to accurately maintain this value.

During this rising voltage period the current normally will be maintained at a rather high level. Once the voltage reaches the desired value, the current will slowly decrease until the geometric capacitance has been essentially charged. The current will then very slowly decrease in time to follow the leakage plus absorption current values, (see Technical Publication 22T1).

Samples greater than 1 μfd can be charged by advancing the Voltage Control so as to follow the output voltmeter rise. This is a special condition and results in charging the sample at a rate just below the rate that will trip the circuit breaker. This charging rate is slower than normal and in general the larger the sample capacitance the longer it will take to build voltage up on the sample.

The largest capacitance that can be tested thus depends on the time factor of the test in progress, (see Technical Publication 22T1 and SECTION H of this manual).

SECTION H

APPLICATION NOTES

A typical test procedure is described as a guide for the application of the test set. Assume as a sample one phase of a new polyethylene power cable 300 ft. long rated 15 kV and of 2/0 conductor size. Based on information contained in the Technical Publication 22T1 the following test is specified:

> "Five 10 kV steps for 1 minute each and a final 5 kV step for 5 minutes. From this specification the cable must be tested at 10, 20, 30, 40 and 50 kV remaining at each step for 1 minute and a final test at 55 kV for 5 minutes."

To perform this test the set and sample are made ready per SECTION E (also see remaining application notes). The set is operational by following steps A through F in SECTION F.

It is assumed that the operator has a watch or clock with a sweep second hand. The operator sets the voltage control to 10, then when the voltmeter reaches 10, he notes the time, selects the range on the current meter and reads the current after an elapsed time of 1 minute. The operator sets the voltage control to 20, records his previous current reading and after an elapsed time of 2 minutes, notes the current, moves the control to 30 and so on. At the end of the test the operator follows the shut-down procedure of SECTION F, steps G through Q. The data is then transferred to the Kilovolt-Megohm paper, the feeder number and other pertinent data recorded and the test points connected. This presents the data for evaluation.

Sample failures will normally not damage the test set regardless of the meter ranges in use.

This set features a crowbar system that acts to cut off the test set very rapidly if a sample fails and, because of the small internal energy storage, limits possible sample damage to that resulting from its own stored energy.

It is not recommended that a failure in a sample be located by repeatedly raising the sample to failure since the test set may be thermally overloaded unless a considerable period is allowed between flashovers (say 1 discharge every 10 minutes) or an external series resistor is used to limit the current to 5 mA.

The High Voltage Unit normally can be located quite close to the sample terminal because of its small size and light weight. This permits connection to the sample using a short jumper made out of 1/4" soft copper tubing or #4 welding cable, or by using the output cable option Cat. No. 222060-60.

If the terminals of the sample present sharp points or corners, the adjacent air may be ionized by electrical stress when energizing the

sample. This appears as leakage current and since such currents can be significant they may tend to mask the true sample currents. To minimize this, increase air clearance or cover such points to prevent ionization. One method is to use KEARNEY AIR SEAL or similar compounds. Another method is to wrap the area with a thin vinyl or plastic film. The thin plastic bags or wrappings used for food storage are convenient.

This Test Set is equipped with a Guard Terminal on the High Voltage Unit. This is a stud wing nut terminal located near the bottom of the case on the side opposite the cable connectors. This must not be grounded or the current meter will not read.

Since Guard is close to ground potential, a sample surface-current to be eliminated from the measurement is intercepted by a temporary electrode attached to the sample surface close to ground. This electrode is connected to the High Voltage Unit Guard.

No ground connection is made to the High Voltage Unit, but it can be placed on a grounded surface or near a vertical ground. It is recommended that a minimum clearance of 15 inches be maintained to smooth grounded verticals. The High Voltage Unit can be operated in any position, but is balanced for use in the base-down position and may require additional support for other attitudes. Clean, dry, nylon safety rope or the web belt carrying handle can be used for this purpose.

The High Voltage Unit case is made of a strong insulating material and is coated to prevent the accumulation of static charges. While both the inside and outside surfaces are coated, reasonable care should be taken to avoid scratches.

The Test Set should be protected from direct water entry from spray or rainfall. The jack J100 located in the lower left corner of the panel permits connection of external instruments of the current-indicating or recording type by using mating standard phone plug (Mallory type 75, JGB Part No. 6468-1, or equivalent), with the (-) terminal of the external instrument connected to the plug frame and the (+) terminal to the plug tip. The sample current so measured will be independent of the microammeter range selector switch setting. The internal resistance of instruments used at J100 should preferably not exceed 100,000 ohms. If the external instrument is of the potentiometer form, off-balance potential should be held to less than 5 mV at the jack J100. No protection against surge exists at jack or between Guard and Ground when jack is used.

When testing long cables (in excess of 200-500 feet) or other large distributed parameter systems, a failure in the cable sample under test may cause a second failure at the terminations. The reason is that the step voltage wave initiated by the failure and propagated down the cable (as a transmission line[1]) rises to a value approaching double the test voltage at the effectively open circuit termination.

[1]In common with all other low current dc test sets, the output impedance of the 222060 DTS is much higher than the surge impedance of the line.

APPLICATION NOTES

The operator can be alerted to impending failure by noting the action of the current meter. A sudden increase in current may be a warning that a failure is imminent.

Based on experience and the type of test in progress, a decision can be made as to whether to continue or stop the test.

NOTE: The operator should be familiar with Biddle Technical Publication 22T1 and other applicable technical publications.

While the Test Set is internally protected, a precaution commonly taken to protect the cable and its terminations is to connect a spark gap between the conductor and ground, adjusted to a voltage of about 10 to 20% above the maximum test voltage of the cable.

The spark gap connected directly across the sample terminals adds the spark gap insulation leakage current to the sample current unless a guard circuit is incorporated. A guarded connection will be required when sample currents are small or must be accurately measured and will require that a gap be constructed allowing the interception of the gap insulation leakage current. IEEE standard publication 62 contains information on the principles of guarding as applied to dielectric measurements.

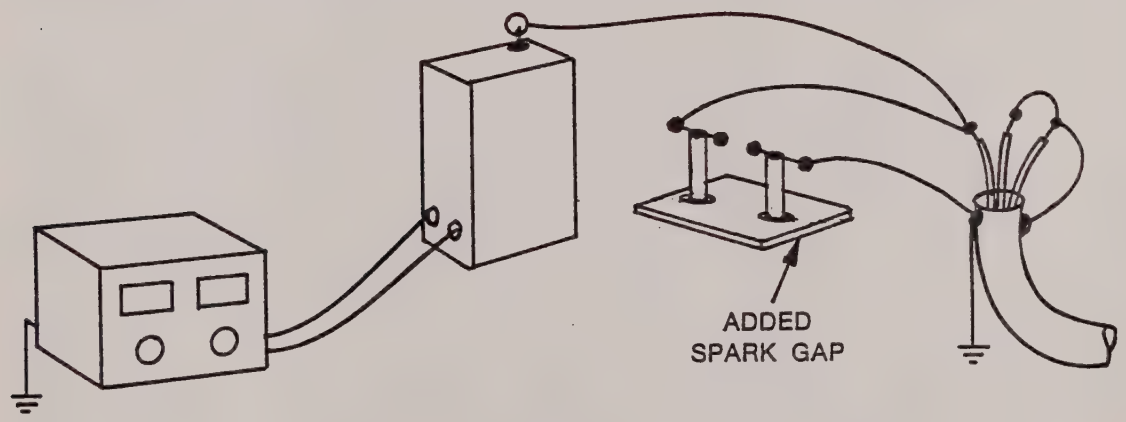


FIGURE 7: PROTECTED TEST CONFIGURATION.

SECTION I

ROUTINE MAINTENANCE

Field service is a difficult environment for high voltage test equipment that can be offset by periodic inspection and cleaning. Performing such inspections and cleaning will increase the reliability of on-site operation.

Deposited dust is the principal problem since it impairs heat transfer from cooling surfaces and, if conductive or hygroscopic, reduces insulation resistance.

Heat is evolved in the Control Unit and dissipated by heat-sinks and a relatively high velocity air stream. This was chosen because dust is blown through and deposits quite slowly on critical areas. DO NOT add an air filter to the ventilation system as this reduces air velocity and tends to clog with dust!

In the High Voltage Unit the precipitation action of the high voltage tends to deposit dust and reduce the effectiveness of the creepage paths provided.

Routine inspection and cleaning will be required at intervals depending on the field conditions encountered. As a guide, once every three months for sets operated indoors with normally dusty atmospheres and at the other extreme, weekly where the set is used daily outdoors with a heavy dust concentration that is conductive and hygroscopic.

The operating controls and indicating lamps warn when difficulties are developing and provide considerable information for troubleshooting when a defect does occur.

The High Voltage Unit uses a case made of an insulating material. Static bound charges are prevented from accumulating on the case surfaces by applying inside as well as outside a high resistance coating. This coating is tough and abrasion resistant but rough usage may result in major damage so that surface charges may accumulate.

ROUTINE MAINTENANCE AND INSPECTION - PROCEDURE

Routine inspection and cleaning has been made simple and takes about one hour.

For cleaning, a clean, soft bristled paint brush about one inch wide is convenient. A small vacuum cleaner with a small flexible pick up hose is better, or if clean, dry, low-pressure air is available it can be used. A clean soft cloth is also helpful.

While cleaning, watch for loose connections or fittings.

ROUTINE MAINTENANCE

To clean the High Voltage Unit, wipe the entire outside of the case, note any damage to the surface. Remove the side panels and remove any dust accumulated on the interior of the unit and side panels. Replace the side panels. As a safety precaution place a short-circuit jumper from the output terminal to guard terminal at least ten minutes prior to the work. After opening the case use an insulated jumper wire to short each capacitor.

To clean the control unit, remove it from its transportation case. Examine the leads for damage or wear and wipe them clean. Clean off the outer surfaces of the control unit case. Clean out the transportation case, especially the lead compartment.

To remove the control unit case cover, first remove the two screws that retain it (see Figure 5, Page E4). Then push the cover straight back from the front panel about 1/4 inch so the edge is visible, and lift the cover off. To remove the circuit cards, press down the front of the plastic clamp rod about 1/32 inch and deflect the cross bar to free the end of the clamp. Remove the cross bar. The cards can then be removed from their keyed circuits. Be careful not to disturb the adjustment screws. Clean the control unit interior. It may be shaken to locate any loose or foreign material lodged in regions hidden from direct view. Carefully clean the circuit cards and return them to their appropriate sockets. Note that each card is so keyed that it will fit into only the proper socket, and only when properly oriented. Clean the fan, being sure that the blades are free and not obstructed. The fan motor is sealed and requires no lubrication. Replace the cover and retaining screws. Return the control unit to its transportation case.

The simplest inspection test is to operate the Test Set without load. Follow the operating instructions. If any failure is noted in the Test Set, refer to SECTION J.

Note that the output voltmeter reading agrees with the setting of the voltage control and that at 60 kV the current meter indicates less than 0.2 microampere. If Cat. No. 222060-60 cable option is in use, leakage may be as high as 0.5 μA,

SECTION J

TROUBLESHOOTING AND REPAIR

In the event that a defect develops in this set, either return it to the factory for repair or follow the procedures outlined below to localize the problem. (Refer to the Parts List for replacement parts.)

Troubleshooting and repair should only be performed by a qualified and competent technician who is familiar with solid state circuitry and the dangers associated with high voltages. If the set is to be operated with ac line-powered measuring equipment, a high quality isolation transformer of at least 1 kVA must be used to power the control unit. The safety ground should remain connected. If the control unit cover is removed only the back panel (with fuse holder) and the front panel are grounded. All other assemblies must be separately grounded.

A. Polarity lamp fails to glow and/or fan fails to run.

Look for: No voltage at supply socket
Defective input cable W1
Blown fuse F2 (commercial type MDL 3/16)
Defective polarity lamp DS1

If the fan will not run when the set is plugged in, regardless of the position of the circuit breaker, the reason must be determined before replacing the fuse. The most likely cause is that the set is connected to a line with voltage in excess of 130V or to a dc source. The second most likely cause is a stalled fan motor, usually because foreign material has become lodged between blade and case. A third possibility is a defective fan motor.

NOTE: To gain access to the control section, disconnect all cables, slide out of the transportation case and follow the procedure given in SECTION I, Routine Maintenance.

B. Circuit breaker trips on closing and/or green lamp will not go on.

Look for: Chassis wiring failure if circuit breaker repeats trip-out on closure.

Check chassis wiring using an ohmmeter. Refer to schematic diagram, Figure 3, page D4.

Breaker can be closed, but green lamp still does not go on.

Look for: Defective Lamp DS2

NOTE: To replace either green or red lamp, remove the Bezel by pulling it straight out to expose the lamp. Extract the lamp and replace with Biddle part or the standard commercial type 334 rated 28V at 0.04 amperes.

C. F1 Fuse blown.

NOTE: This fuse protects the low voltage auxiliary power supplies. The reason must be found since this indicates possible failure of the oscillator-drive and control circuitry.

Look for: To localize the trouble, expose the control unit chassis and remove all circuit cards. Replace the fuse with Biddle part or commercial type MDL 1/2 ampere only. Connect the ground cable to a low resistance ground and plug set in. Close the circuit breaker and note if green lamp comes on and remains on. If the lamp does not stay on (F1 blows) the trouble is in the main chassis or in the driver transistors Q200 or Q204. See Fig. 5, Page E4. To localize further, remove the wire feed to these transistors as noted on the Figure. Open the circuit breaker, wait 10 minutes, replace the fuse and try again. If the fuse holds, the transistors are probably defective and usually both must be replaced. If circuit board E200 is plugged in while Q200, Q204 or their protective diodes are faulty, Q201 and Q203 on E200 will be damaged.

If the fuse fails, the problem is in the main chassis. The schematic diagram and normal circuit tracing techniques can be used to find the defect.

NOTE: To gain access to chassis wiring, perform the following additional steps on the chassis: Remove the four corner screws from the panel so that it is free. Invert the control unit but support the main chassis, remove the three screws holding the small rear cable panel and the four screws holding the main chassis to the case. Tilt the front panel and slide the case frame off. The underside of the main chassis is now exposed. Reverse this procedure for reassembly.

If main chassis and driver transistors are not at fault, the trouble is in one of the circuit boards. The symptom is a failure to hold the green lamp and/or the circuit breaker trips out when attempting normal operation but neither failure occurs when the circuit boards are removed. To localize the board shut the set down, wait 15 minutes then replace the board closest to the panel, also replace the fuse and re-energize. Continue adding circuit boards in this fashion making sure to advance the voltage control to 30 each time until the fuse fails. The last board added contains the defect.

To correct the difficulty it is recommended that a replacement circuit board be obtained from the factory since repair of these boards requires some special techniques. Replacement boards may not be adjusted for optimum performance so it is recommended that after the immediate test program is completed, the entire set be returned to the factory for tune-up and overhaul.

D. With VOLTAGE CONTROL held at zero, red lamp goes on without pressing START button.

Look for: Stuck relay contactor K2

E. When START button is pressed, circuit breaker trips and/or red lamp will not go on.

Look for: Excess or deficiency in line voltage.

If the circuit breaker trips out when the START button is pressed or if the set buzzes and the red lamp takes more than about 15 seconds to go on, make sure the line voltage is correct. A high line (over 125 volts) will result in breaker trip-out when the green (START) button is pressed. A low line will make the set buzz when the green (START) button is pressed, and the red lamp will be slow in going on.

Defective red lamp.

Look for: Possible overheated power converter transistors if set was previously under load. Wait ten minutes with the fan running and try again. If the problem persists, or if the same condition exists with no load or with the High Voltage Unit disconnected, the set should be returned to the factory. Further localization must be by competent skilled personnel. To proceed further, remove the Main Power Converter test link shown in Figure 5, Page E4. Re-energize, and if the red lamp then goes on, the problem is in the main power converter or crowbar circuits. The transistors of the main converter usually fail in pairs; these must be located and replaced. The crowbar SCR can be isolated by removing the anode connection to distinguish between main converter failure and crowbar failure. A defective crowbar can be replaced by the Biddle part or its commercial equivalent, No. 2N3897. The reason for the failure must be corrected.

NOTE: To gain access to the components on the power converter board, remove the four screws (two on each side plate) that hold it in place, and cut the tie-wrap holding the leads to the fan housing. The power converter board can then be folded out. Do not have the set plugged in when in this position.

An "in-circuit" transistor tester can then be used to locate defective transistors, provided the base drive board (E301) is removed. Reverse the operation to reassemble the set.

With power converter test link open, red lamp still does not go on.

Look for: Defect in the main chassis wiring or components, particularly of the main power supply (403), CRB400 or R405.

NOTE: Failure of R405 is usually caused by a failure of CRB400 or the power conversion section.

F. Metering.

NOTE: The meters and components on the front panel are accessible by removing the four corner panel screws and folding down the panel.

No current reading under load.

Look for: Faulty ground connection to Guard.
Shorted interconnecting cable.
Defective Zener on board E100
Defective meter.

Incorrect current readings.

Look for: Recalibration of current meter.

The current meter can be recalibrated if a standard current meter and a suitable load resistor are available. (See Figure 8, Page J6, for connections.) As an alternate, if a variable dc supply of 500V and 50 mA capability is available together with a standard current meter, calibration can be performed without energizing the Test Set by connecting the standard current meter, a ballast resistance and the power supply in series and applying this between the ground and Guard of the Test Set, (Guard positive with respect to ground). Guard is available at the interconnecting cable plug terminal D.

The current meters can then be compared over the full range of the Test Meter. See Figure 4, Page E3, for location of current meter calibration adjustment (under a cover screw). A non-linear meter reading on the high sensitivity scales usually indicates high leakage current in the zener diode on board E100.

Suspected error in voltmeter.

Look for: Recalibration of voltmeter.

To adjust the voltmeter, a high accuracy dc kilovoltmeter drawing no more than 1 milliampere is required. This is connected as a load and compared to the Test Set voltmeter. The adjustments are accessible after the screw plugs are removed (see Figure 4, Page E3). Note that separate adjustments are provided for each range, and calibration should be performed at full scale after a 10-minute warmup period.

The remaining items are not associated with a particular operating step.

The circuit boards have adjustment potentiometers. (See Figure 8, Page J6.)

Span control, R612 on circuit board 14114.

Frequency control, R239 on circuit board 14113.

Drive level control, R217 on circuit board 14113.

Current trip level control, R307 on circuit board 14128.

TROUBLESHOOTING AND REPAIR

All adjustments have been made at the factory and normally will not require attention unless a major repair requires component changes. Of these, only the span control can be readjusted in the field. All other adjustments must be considered "Factory-Only" procedures as they require special equipment and techniques.

G. Output voltage differs from VOLTAGE CONTROL setting.

Look for: Adjustment of span control.

To reset the span adjustment, operate the set with the control case cover removed but with the High Voltage Unit connected without load. Set the VOLTAGE CONTROL to 60 kV, then adjust the span control so that the output voltmeter reads exactly 60 kV. The low voltage end of the scale may not agree, but will provide good repeatability of setting.

No output voltage.

Look for: If the control unit is operating correctly but there is no high voltage output, the High Voltage Unit must be examined.

NOTE: Troubleshooting of the High Voltage Unit should be undertaken only by competent personnel since there may be a shock hazard involved. A 1000 volt Megger(R) insulation tester is required.

Remove the side plates, discharge each capacitor and examine the wiring including the interconnecting sockets for obvious defects. If none exist, check the rectifier assemblies in pairs or individually.

Using the Megger instrument, check each rectifier for a forward resistance of about 30,000 ohms and a reverse resistance of greater than 500 megohms. Check each capacitor of each bank; insulation resistance should be in excess of 5000 megohms. Check the output limiting resistor; resistance should be no more than 40,000 ohms. Replace defective components. See Parts List for the Biddle Part Number.

The High Voltage transformer must not be excited from 60 Hz and should be tested only for continuity. The secondary will measure about 400 ohms, the primary about 0.05 ohms. The insulation resistance primary to secondary must exceed 5000 megohms at 1000 volts.

If accumulation of external surface charge is suspected, check by energizing the Test Set to full voltage, no load, for five minutes. Then shut down, wait until the voltmeter reads zero, and explore the box surface with a grounded hot stick. A trapped surface charge will spark to the stick and produce a current meter kick. If surface damage has occurred and is sufficient to warrant correction, the defective member can be repaired or replaced. Consult factory for procedure.

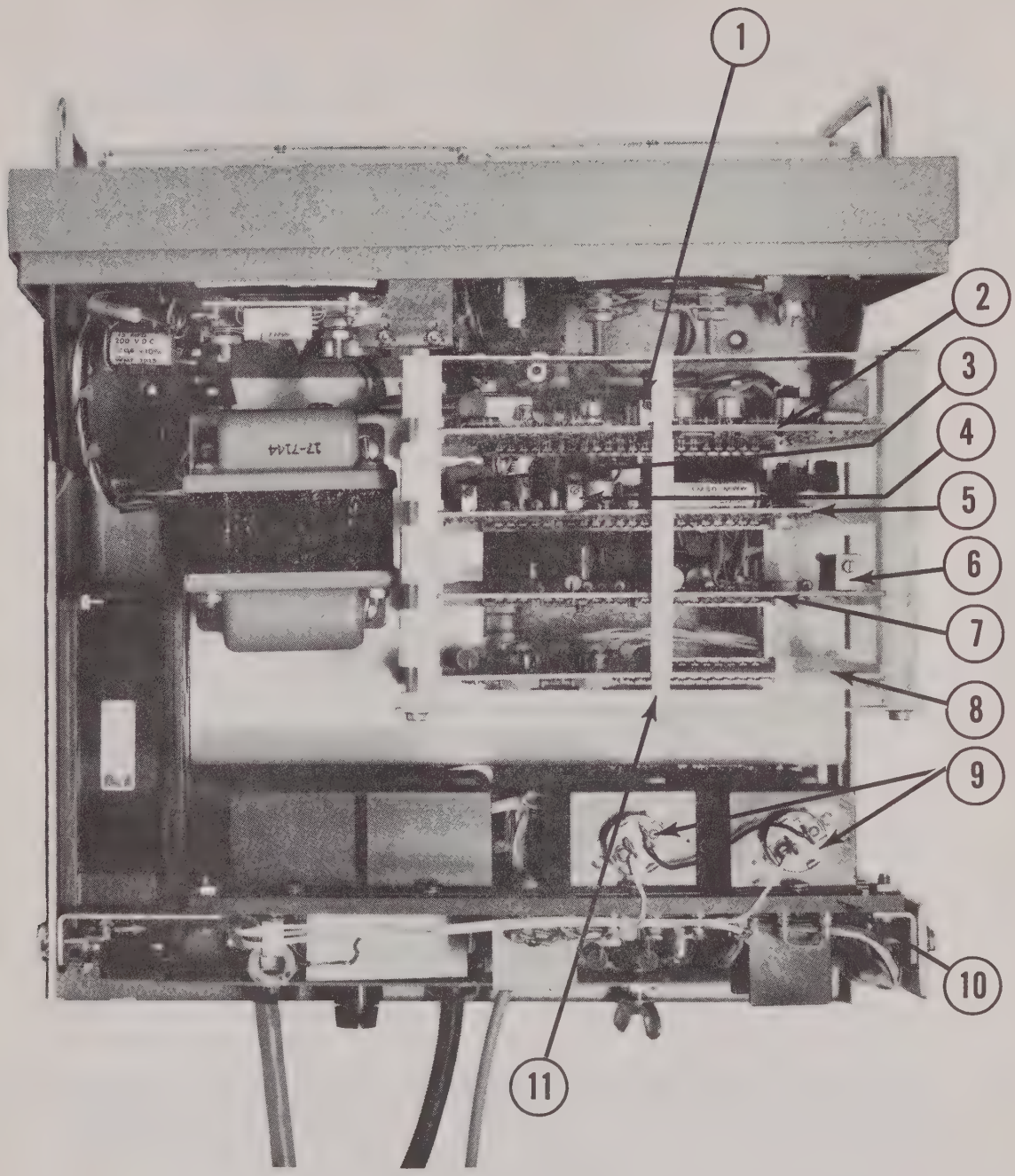


FIGURE 8: INTERIOR VIEW OF CONTROL UNIT

1. Span Control (R612)
2. Circuit Board (E600)
3. Frequency Control
4. Drive Control (R217)
5. Circuit Board (E200)
6. Current Trip Level Control (R307)
7. Circuit Board (E303)
8. Circuit Board (E301)
9. Thermal Switches (S4, S5)
10. Power Converter Board (E300)
11. Clamp Rod

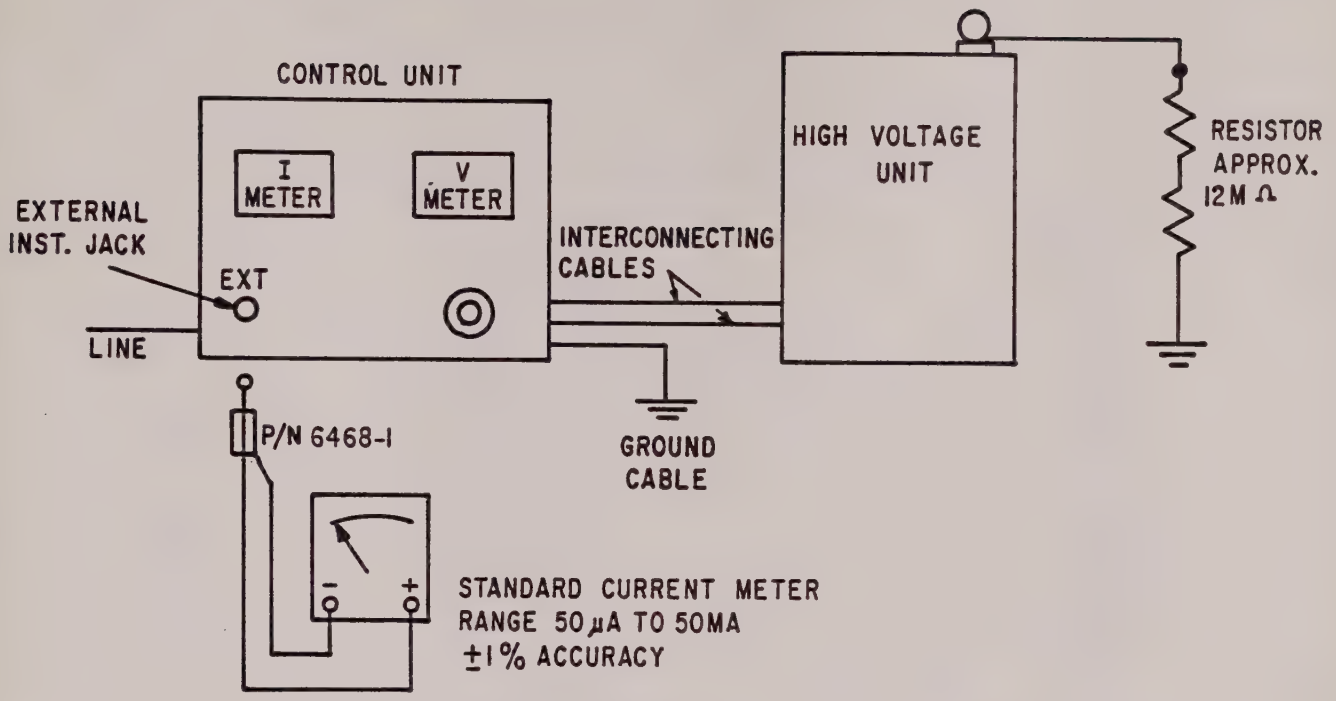


FIGURE 9: CALIBRATION TEST CONNECTIONS

H I G H V O L T A G E!

OBSERVE ALL SAFETY PRECAUTIONS!

1. Connect according to this sketch; observe safety precautions.

2. Standard current meter range selected to read 50 μA, Test Set on 50 μA range.

3. Energize Test Set, raise output until standard meter reads 50 μA and compare this with Test Set current meter reading for correlation to ±2%.

4. Selecting each range 50, 500 μA and 5 mA in turn, make comparison at full scale for an accuracy of ±2%. Set current meter calibration adjustment for this.

5. Comparisons made at any other scale points will read the nominal value ±2% of full scale.

6. With this test the base range of 5 μA of the Test Set is assumed accurate, no provision is made for calibration. In this setup the 50 mA range cannot be checked at full scale since the Test Set is arranged to trip out a little above 5 mA.

SECTION K

PARTS LIST

NOTE: Most circuit symbols are shown on Figure 3, Further identification can be made by referring to Figures 4, 5, and 8.

SYMBOL	DESCRIPTION	JGB PART NO.
W1	Cable, Input	4127
W2	Cable, Ground	4702
W3	Cable, Interconnecting	7749
W4	Cable, Interconnecting	6467
C1, C2	Capacitor, Dual .1μf, 600 V	8341-4
C400	Capacitor	12146-2
C401	Capacitor	7950-2
C402	Capacitor	4559-2
C403	Capacitor	12146-3
C404	Capacitor	4559-2
C500-516	Capacitor	14030-1
K1	Circuit Breaker	6807-3
M101	Current Meter	4977
J500	Connector, 2 pins	9018-22
J501	Connector, 4 pins	9018-26
VR201	Diode, Zener (Unitrode VZ5815)	12074-6
J100	External Instrument Jack	4733-2
B1	Fan	9741
F1	Fuse, 1/2 Amp. S.B.	2567-16
F2	Fuse, 3/16 Amp. S.B.	2567-17
DS2/DS3	Lamps (2)	5297
DS1	Lamp, Neon	4499-1
DS2	Lens, Green	6847-3
DS3	Lens, Red	6847-2
E600	P.C. Control Board	14114
E200	P.C. Board (Oscillator Driver)	14130
E303	P.C. Board (S.C.R.)	14112
E301	P.C. Board (Base Driver)	14097
E300	Power Converter Board	14004
CRB400	Rectifier Bridge	14267
CRB401	Rectifier Bridge	14043-2
CRB402	Rectifier Bridge	14043-1
RCR500-503	Rectifier Assembly	14056
K2	Relay	14265
R400	Resistor	6869-2
R403	Resistor	14266-2
R401	Resistor	4505-1
R404	Resistor	4505-1
R405	Resistor	14266-1

PARTS LIST

SYMBOL	DESCRIPTION	JGB PART NO.
R102	Resistor, Variable	4384-15
R104	Resistor, Variable	4384-13
R500	Resistor	4553-12
R501	Resistor Assembly	14055
R504	Resistor Assembly	14100
S1	Switch (Start)	6847-20
S2	Switch (Stop)	6847-20
S3	Switch (Zero Start)	6901
S4	Switch (Thermal)	14163
S5	Switch (Thermal)	14163
S100	Switch	8401-1
E100	Standard Current Meter Ckt.	14063
T400	Transformer	14050-1
T401	Transformer	14050-2
T500	Transformer (H.V.)	14040
M100	Voltmeter	14035
E102	Voltmeter Card Assembly	14084
L400	Choke	14089

SECTION L

WARRANTY AND REPAIR

WARRANTY

All products supplied by the James G. Biddle Co. are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance as indicated in the manual.

REPAIRS

The James G. Biddle Co. maintains a complete instrument repair service. Should this instrument ever require repairs, we recommend it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, and marked for the attention of the Instrument Service Manager.

A-14-D

GENERAL ELECTRIC

APPARATUS SERVICE BUSINESS DIVISION

LOCATION—DATE
- Schenectady, N. Y. - Bldg. 6 - 328
  September 6, 1979

COPIES:

DIAL COMM NUMBER
- 8*235-9912

SUBJECT
-

To: All Telco Shops

The enclosed is Sierra's MTP for their model 417A Drawing A0319-1400.

You should use the Northeast MDL 7040 to simulate the test fixture, utilizing the 7040 artificial line to simulate the distance specified in the charts.

Tom.

T.W. Oakes, Specialist - Market Development
Instrument Repair, Calibration & Standards Service
INSTRUMENTATION AND COMMUNICATION EQUIPMENT SERVICE PROGRAMS

/rg
Enclosure

RECEIVED
SEP 10 1979

REVISIONS

SYM	DESCRIPTION		DATE	APPROVED
A	PILOT RUN RELEASE		4-21-76	
	PRE-PRODUCTION RELEASE		8-12-76	
A1	PCO 2247		4/21/77	
B	PRODUCTION RELEASE		4/5/77	
C	ECO 16664	A.S.	6-14-77	
D	ECO 16723	A.S.	8-12-77	

NEXT ASSY.	QTY	MODEL NO.
		417A-1
		417A-2

Sierra

LEAR SIEGLER, INC.
SIERRA ELECTRONIC DIVISION
MENLO PARK, CALIFORNIA 94025

CODE IDENT. NO. 54778

PRODUCTION TEST PROCEDURE
FOR
Model 417A

DATE	SIZE	DRAWING NO.	REV
12-19-75	A	A03191400	D

BY T C Robinson

APPR'D/

STOCK AS

SHEET 1 OF 23

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1.0 SCOPE

1.1 Object

This procedure contains the manufacturing testing requirements necessary to perform production alignment and unit acceptance tests of the Sierra 417A-2,-11 PCM Line and Regenerator Test Set.

1.2 Test Report

1.2.1 The Test Report to be used for the Acceptance Test Section of this procedure is the 417A Acceptance Test Report Drawing No. A03191500. The Test Report for this instrument is no longer deemed to be required unless otherwise requested.

2.0 APPLICABLE DOCUMENTS

2.1 Schematics

417A

Interconnect Diagram, 417A-2	D03178800	
Interconnect Diagram 417A-11	D03178900	
A1 Termination/Repeater	C03178300	
A2A ALBO Regenerator	D03199200	for A03199400 Assy.
	OR	
	C03178400	for A03111700 Assy.
A2B No Data/Low Output	D03195200	
A3 Error Detector	C03178500	
A4 Power Loop/Meter CKT.	C03178600	
A5 Motherboard	D03178700	

CODE IDENT NO.	SIZE	DRAWING NO.
~~94668~~	A	A03191400
SCALE		SHEET 3

3.0 REQUIREMENTS

3.1 Test Equipment and Accessories

Qty.	Description	Recommended
1	Oscilloscope	TEK R7603
1	Time Base Plug-In	TEK 7A18
1	Vertical Amp. Plug-In	TEK 7B50
1	Digital Multimeter	Fluke 8000A
1	Power Supply Dual	HP 6205B
1	Power Supply	HP 895A
1	Flameless Heat Gun	
8	Dry Cell Batteries, Size D	918500006
1	Counter	HP 5300B with 5308A
	417A-2 ONLY	
2	310 Cable	916400037
1	310 Cable, Terminated	TF00164
	417A-11 ONLY	
1	310 to CF Cable	TF00115
1	310 to CF, Terminated	TF00163
1	310 Cable	916400037

3.2 Test Fixtures

Description	Sierra P/N
417A Unit Interface Panel	TF00117
PCM Test Generator	TF00091-2
RPTR. Substitute	TF00123

3.3 Test Station

3.3.1 The above test equipment and Interface Panel shall be securely mounted in 19" racks and interconnected with the unit under test per Figure 9.1.

4.0 DEFINITIONS and ABBREVIATIONS

SCOPE	Oscilloscope
GEN.	Generator
DMM	Digital Multimeter
V p-p	Volts, Peak-To-Peak
UNI-DIR (UNI)	Uni-Directional
BI-DIR (BI)	Bi-Directional
TF	Test Fixture (417A Unit Interface Panel)
A > B	A is greater than B
A < B	A is less than B
A ≧ B	A is greater than or equal to B
A ≦ B	A is less than or equal to B
CW (FCW)	Clockwise (Full)
CCW (FCCW)	Counter Clockwise (Full)
DET.	Detector
A/R	As Required
TERM.	Termination
RPTR.	Repeater
NORM.	Normal
SW.	Switch
THRS.	Threshold
CAL.	Calibration
U.U.T.	Unit Under Test

4.0 DEFINITIONS and ABBREVIATIONS (continued)

N/A	Not Applicable
DOM.	Domestic
EURO.	European
FOR.	Foreign
P/E	Pulse/Error
ART.	Artificial
XMIT	Transmit
SIM.	Simulator
SUB.	Substitute
CURR	Current

5.0 PRELIMINARY ALIGNMENT

5.1 Visual Inspection

5.1.1 Check all harness wiring for proper and secure connection/s to motherboard, etc.

5.1.2 Ensure that the proper fuse is installed.

5.1.3 Check for easy rotation of rotary switches.

5.1.4 Check for proper knob installation and index registration.

5.1.5 Ensure all P.C.' boards are fully seated in their connectors.

5.2 Equipment Warm-Up

5.2.1 All test equipment should be interconnected per Figure 9.1 and allowed a 30 minute warm-up period before starting test.

5.3 Test Set-Up

5.3.1 Prior to test and connection of the 417A to the Interface Panel, ensure the following conditions are met:

CAUTION: AVOID TOUCHING DMM CONNECTIONS OR PROBE CABLE PINS WHEN THE INTERFACE PANEL SELECT SWITCH IS SET TO A 300 or B 300 POSITION.

5.3.1.1 Set the HP 895A Power Supply to 300V DC with the Interface Panel Select switch set to "A 300" as monitored by the DMM. Subsequently set the "select" switch to "cal" position.

Instant 10-40 Eat Signed Here

5.3.1.2 Install the Substitute Repeater into the 417A repeater well.

5.3.1.3 Prior to connecting the 417A to "Power" or Interface Panel Cable, verify with Ohmmeter from either SUB. RPTR. "Loop Voltage" Jack to the 417A chassis that the measured resistance is NOT LESS than 1.20M Ohm. Perform this test with SUB. RPTR. "Side 1" pushbutton depressed for BOTH positions of SUB. RPTR. "Rptr. Z" toggle switch.

5.0 PRELIMINARY ALIGNMENT (continued)

5.4 Test Table

5.4.1 The 417A is to be preliminarily tested to Table 5.6 per "Input" settings for respective "Output" requirements.

5.4.2 Test table input settings will remain unchanged from test to test/s unless otherwise specified by the test table for any given test.

5.4.3 An asterick (*) will indicate switch setting changes from preceeding to succeeding test table sheets.

5.4.4 Figure diagrams may be referred to in Section 9 as required thru-out testing.

5.4.5 The parenthesis symbol in the Test Table "(.....)" will distinguish the 417A-2 from the 417A-11. Always observe "comment" in Test Table.

5.5 417A Test Connections

5.5.1 Connect the 417A to the Interface Panel per Figure 9.1.

5.6 Test the 417A per the following table:

TABLE 5.6 417A UNIT PRELIMINARY ALIGNMENT

ITEM	TEST	PCM GENERATOR: POWER	NOISE	SIM	MOD	PULSE	PERIOD	XMIT	LOOP	SYSTEM	DISABLE	AKT. LINE	UNIT INTERFACE PANEL: BYPASS	BATTERY	SELECT	CURRENT	MONITOR	RPTR	TERM	417A INSTRUMENT SWITCHES: POWER	INTERR	FORMAT	METER	PE DET.	PWR LOOP CUR. ADJ.	PWR LOOP	TERM	RPTR	WELL RPTR SUPPLY	OUTPUT REQUIREMENTS: TEST POINTS	DMM	417A METER	417A LOOP: LOW OUTPUT	PWR LOOP	PULSES	ERRORS	COMMENTS
1	SIGNAL FLOW AND CONTINUITY	ON	OFF	OFF	14	NORM	ALL 1	TI (Euro)	Remote OFF	5	OFF	12	A+	N/A	AB	B1-1	DOM (For.)	ON	OUT	1544 (AMI)	A mo NORM	RPTR INPUT	FULL CCW	OFF	NORM	B1-1	SIDE 1, RPTR Z1	SCOPE: 540.5 VPP	N/A	N/A	N/A	N/A	N/A	N/A	Connect PCM Pulse Gen. out to line sim. input on Inter. Panel
	B1 SIDE 1														HJ										↓				NO SIGNAL							
															AB										Side 1											
															↓										Both											
															DE										↓				640.5 VPP							Monitor SCOPE PER TEST Point Column
															↓										Side 1											
															AB										Loop				NO SIGNAL							
															HJ	↓										↓			540.5 VPP							Polarity may change PER TEST
	B1 SIDE 2														AB	B1-2										B1-2										
															HJ										↓				NO SIGNAL							
															↓										Both											
															↓										Side 2											
															LM										↓				640.5 VPP							Ensure that 310 to 310 cable is NOT connected to Neither 417A UUT Nor Interface panel 310 bridging jacks.
															↓										Both											
															AB										NORM				NO SIGNAL							
															HJ	↓										↓			540.5 VPP							
	UNI SIDE 1														AB	UNI-										UNI-1										
															HJ										↓				NO SIGNAL							
															AB										Side 1											
															↓										Both											
															DE										↓				640.5 VPP							
															↓										Side 1											
															AB										FROG				NO SIGNAL							
															LM	↓										↓			540.5 VPP							
	UNI SIDE 2														AB	UNI-2										UNI-2										
															LM										↓				NO SIGNAL							
															HJ										Both				640.5 VPP							
															↓										Side 2											
															LM										↓				NO SIGNAL							
															↓										Both											
	FAULT LOC.														↓										NORM				540.5 VPP							
															AB	↓										↓			NO SIGNAL							
		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	Fault Loc.	B1-1	↓	↓	↓	↓	↓	↓	↓	↓	↓	B1-1	Fault Loc.	0.55 40.1 VPP							

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TABLE 5.6 417A UNIT PRELIMINARY ALIGNMENT (Continued)

ITEM	TEST	ACM GENERATOR: POWER	NOISE SIM	MOD	PULSE PERIOD	XMIT	FUNCTION	SYSTEM	DISABLE	ART. LINE	UNIT INTERFACE PANEL: BY PASS	BATTERY	SELECT	OFF LINE CURRENT	MONITOR	RPTR	TERM	417A INSTRUMENT SWITCHES: POWER	INTERLOCK	FORMAT	METER	PE DET.	Power Loop CUR. ADJ.	Power Loop	TERM	RPTR	SUB RPTR	WELL
2	BATT.	ON	OFF	OFF	14	NORM	ALL	TI (Euro)	Remote OFF	5	OFF	12	A+	N/A	N/A	B1-1	DOM (For.)	OFF*	OUT	1544 (AMI)	A ma NORM	RPTR IN	FULL CCW	OFF	NORM	B1-1	Side 1,* RPTR Z1
	METER CIRCUITS																	BATT. CHK.									
																			IN								
												8							OUT								
	WEST CURR.											12		Adj. per DMM specified value				ON			A ma REV.						
													A-								B ma NORM						
	EAST CURR.												B+								B ma REV.						
													B-														
	RPTR. VOLTS												CAL.	N/A							Rptr volts (Side 2 Volts)						Fault Loc.
													Thrs.														Side 1 Rptr Z1
	417A-11 Only												A 30 (B 30)								(Side 2 Volts)		Adj. per DMM	A (B)			Side 1 Rptr Z2)
3	POWER LOOP REGULATOR												A 30								A ma NORM			A			Side 1 Rptr Z1
													A 300														
													B 30								B ma NORM			B			
													B 300														
													B 30														
																							Prior Adj. not change				
															MON IN						N/A		N/A				
4	RPTR IN/OUT																										Depress "Out. Low"
																											Release "Out. Low"
																B1-2										B1-2	
																UNI-1										UNI-1	
																UNI-2										UNI-2	
																						Rptr OUT					
																UNI-1										UNI-1	
																B1-2										B1-2	
																B1-1										B1-1	
	NO DATA					Stop XMIT																					

ITEM	TEST	OUTPUT REQUIREMENTS: TEST POINT/S	DMM	417A METER	417A Indicator Lamp: LOW OUTPUT	PWR LOOP	PULSES	ERRORS	COMMENTS
2	BATT.	417A METER	N/A	Exactly 0 vdc	N/A	OFF	OFF	OFF	Adjust 417A Meter ZERO A/R
	METER CIRCUITS			12vdc Exactly			N/A	N/A	Adj. A4-R10 for 417A Meter 12 vdc
				0 vdc			OFF	OFF	N/A
				840.5 vdc			N/A	N/A	Verify 417A PWR ON Lamp Illuminated
	WEST CURR.		140 ma (Same)	140 ma					Adj. A4-R7 A/R for 417A Meter = DMM value
	EAST CURR.								Adj. A4-R9 A/R for 417A Meter = DMM value
			100 ma	100 ma ±5 ma					Adjust "Office Current" pot. on Interface Panel to specified DMM value
			30 ma	30 ma ±5 ma					
	RPTR. VOLTS		15.3 vdc ±0.05vdc	15.0vdc Exactly					Adj. A4-R14 for 417A Meter Value ~ 15.0vdc
			Approx. 20 vdc	0 vdc ±0.5 vdc					N/A
	417A-11 Only		140 ma	10.5 vdc ±0.5 vdc		ON			Adj. 417A PWR Loop Pot for DMM value
									417-11 Only
3	POWER LOOP REGULATOR		30 ma thru 140 ma Current Range Span.						Verify PWR loop current span by adjusting 417A Cur Adj. Pot. on front panel.
			140 ma	140 ma ±5 ma					Adj. 417A Cur. Adj. Pot to 140 ma.
			0 ma ± 5 ma			OFF			Apply heat to A4-ST, Term. Switch until P/L lamp is OFF
			140 ma ±5 ma			ON			Verify PWR Loop Indicator Lamp & Current Recover after cool down
4	RPTR IN/OUT	"Note 1"	N/A	N/A	ON		ON		Ensure cable is between 417A Mon. Jack and T.F. Mon. In Jack
		(Scope) 4±2 VPP Required for each test step			OFF				Polarity of waveform may change from step to step
					N/A				Turn OFF HP895 Power Supply
	NO DATA	Note 2					OFF	OFF	Adjust 417A A2B K22 per Note 2

*Changed from prior Test Table sheet.

NOTE 1: WHILE depressing the SUB RPTR "Output Low" button, adjust the 417A A2B-R30 pot. (CCW) until the 417A "Low Output" Lamp just begins to extinguish, then back off the adjustment TWO turn in the opposite direction (CW) such that the Lamp is solidly illuminated. Verify the Lamp extinguishes when the "button" is released.

NOTE 2: Verify the 417A "No Data" Lamps' status ONLY when "Stop Xmit" is initiated. Therefore, adjust 417A A2B-R22 for for -40 mvdc as indicated across TP2 (+ terminal) to TP1 (- terminal) of said board WHILE "Stop Xmit" is depressed; then verify the "No Data" F/E lamps off) as previously stated. (Restore DMM connections to Interface Panel, if so used, and

continue the preliminary alignment test starting from sheet 1)

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417A-2 ONLY — This Table Intended for 417A-2 Only — TABLE 5.6 — 417A UNIT PRELIMINARY ALIGNMENT (continued)

TEST	PCM GENERATOR: POWER	NOISE	SIM	MOD	PULSE	PER UD	XMIT	FUNC Ord	SYSTEM	DATA	ART. LINE	UNIT INTERFACE PANEL: BY-PASS	RATE	SELECT	OFFICE CURRENT	MONITOR	RPTR	TERM	417A INSTRUMENT SWITCHES: POWER	INTERLOCK	FORMAT	METER	P/E DET.	Power Loop: CUR. ADJ.	Power Loop:	TERM	RPTR	WELL: SUT B.R	OUTPUT REQUIREMENTS: TEST POINT/S	DMM	417A METER	417A Indicator Lamp: LOW OUTPUT	PWR LOOP	PULSES	ERRORS	COMMENTS
ALBO Alignment, Equalization	ON	OFF	OFF		14		Norm	QRW* Coded	T148*	Remote OFF*	24*	OFF	10*	B 30	N/A	Mon In	BI-1	DOM	QN	Out	2370*	N/A	RPTR Input	N/A	B	Norm	BI-1	Side 1 RPTR Z 1	Note 3, Observe Scope Waveform	N/A	N/A	N/A	On	N/A	N/A	Connect PCM line Sim. output to Inter. Panel Line Sim. Input via 310 Cable. See Note 3.
ALBO Alignment, Regenerated Clock							Stop Xmit	Bipolar pp	EURO												1544								Observe counter frequency indication							See Note 4. Then adjust A2A-C34 for a counter indication of 1.544 MHz ±5.0KHz.
																					3152															Adjust A2A-R77 for a counter indication of 3.152 MHz ±5.0 KHz.
							↓		↓												2370															Verify a counter indication of 2.370MHz ±25.0KHz.
Reference Test Step							Norm		TI												1544															Remove short circuit jumper from A2A-TP3 to TP4; re-install the A2A Pwb into its well location with 417A power temporarily off. Then adjust A2A R74 until the counter indicates "inlock" condition 1.544 MHz ±78HZ.
							Stop Xmit																										OFF	OFF	Counter freq. drifts away from 1.544 MHz.
							Norm																										ON		Verify in lock condition results 1.544MHz ±78Hz. If not, see Note 5.
							Note 6 ↓		↓			8																							Verify in lock condition results 2.370MHz ±119Hz. Note 5.
												12																							
							Norm		T148			10									2370															
							Stop Xmit					↓																						OFF		Counter freq. drifts away from 2.370MHz.
							Norm					8																					ON		Verify in lock condition results 2.370MHz ±119Hz. Note 5.
							Note 6 ↓					12																							

ILLUSTRATION: Open "Eye Pattern"

Changed from prior Test Table sheet switch settings.

Note 3: Connect scope to A2A-TP1 via X10 probe with its pigtail fastened to A2A-TP Gnd. Then adjust A2A-R26 for the most open "Eye Pattern" as illustrated.

Note 4: (1) Temporarily turn off 417A power in order to place the 417A A2A (ALBO) PWB on an extender card in the 417A chassis.
(2) Connect the scope to A3-R25, left end. (Using X10 probe with its pigtail connected to 417A chassis ground); set scope vertical gain to maximum.
(3) Connect BNC Cable between the scope "vertical output jack" (on back of scope) to the counter input jack.
(4) Short circuit A2A-TP3 to TP4 with shortest possible jumper.
(5) Do not remove the A2A shields when calibrating or testing.

Note 5: If "lock" fails to occur, readjust A2A-R74 until "inlock" results and then repeat all test steps preceding this test step starting from "Reference Test Step."

Note 6: Momentarily stop Xmit.

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This Table Intended for 417A-2 Only

TABLE 5.6

417A UNIT PRELIMINARY ALIGNMENT (continued)

417A-2 ONLY	TEST	PCM GENERATOR									UNIT INTERFACE PANEL							417A INSTRUMENT SWITCHES									WELL	OUTPUT REQUIREMENTS						COMMENT
		POWER	NOISE SIM	MOD	PULSE PERIOD	XMIT	LOCAL	SYSTEM	DIAL PULSE	ART. LINE	BY-PASS	BATTERY	SELECT	OFFICE CURRENT	MONITOR	RPTR	TERM	POWER	INTERLOCK	FORMAT	METER	P/E DET.	Power Lamp CUR. ADJ.	Power Lamp	TERM	RPTR	SUB. RPTR	TEST POINT/S	DMM	417A METER	417A Indicator Lamp LOW OUTPUT	417A Indicator Lamp PWR LOOP	417A Indicator Lamp PULSES	417A Indicator Lamp ERRORS	
	ALBO Alignment, Regenerated Clock (continued)	On	Off	Off	14	Norm	Bipolar PP	TIC*	After Kick On	24	Off	10*	B 30	N/A	Mon In	BI-I	DOM	On	Out	3152*	N/A	RPTR Input	N/A	B	Norm	BI-I	Side 1 RPTR Z 1	Observe counter frequency indications.	N/A	N/A	N/A	ON	ON	Off	Verify Inlock condition results, 3.152 MHz 4158Hz Note 5.
						Stop Xmit for 5 sec.																												Counter freq. drifts away from 3.152 MHz.
						Norm																										On		Verify Inlock condition results, 3.152 MHz 4158Hz Note 5.
						Note 6						8																						
												12								see comment.														
7.	Equalization Performance TIC SYS T1 SYS T148 SYS					Norm	QRW coded for "T148" QRW AMI for "T1" & "TIC"	see comment.	After-kick on for TIC SYS ONLY	5	see comment.																	417A Lamps							Verify the specified 417A lamps' status for System T148, 2,370, for Inter. Panel Battery voltage 12, 10, and 8 selections for Art Line Codes 5 thru 33 ONLY. See Note 7. Repeat for System TIC, 3.152, codes 5 thru 40 & System T1, 1.544 Codes 5 thru 36.
										9																								
										16																								
										24																								
										31																								
										33																								
										36																								
										38																								
										40																								
	As specified:					Norm Xmit Errors	QRW AMI	T1	Remote Off	5		10								1544		RPTR Out											Flash	
							QRW Coded	T148												2370													Off	
						Norm														3152													Flash	Connect 310 cable between PCM GEN PULSE GEN output and Inter. Panel Line SIM. Input jacks & Connect 310 TERM** cable between Inter. Panel and 417A 310 bridging jacks.
						Xmit Errors	QRW AMI	TIC	After-kick on.																									
8.	Bridging, High Level Equalization					Norm with Xmit Errors	QRW Coded	T148	Remote Off											2370													Off	
												8																						
												12																						
							Bipolar PP	T1												1544															
												10																						
												8																						
9.	Signal Interlock					Norm						10																				OFF		Remove TERM cable from Inter. Panel end ONLY.

*Changed from prior Test Table switch setting.

Note 5: If lock fails to occur, readjust A2A-R74 until "InLock" results and then repeat all test steps preceding this test step starting from the "Reference Test Step".

Note 6: Momentarily stop Xmit.

Note 7: Slight "trim" adjustment of A2A-R26 may be required to ensure specified ART LINE codes function with "error free" 417A Lamp Indication; however, DO NOT attempt to optimize A2A-R26 adjustment to include ART LINE code 36 or higher for T148 System as any untoward adjustment will adversely compromise "high level" equalization performance. This may become evident subsequently.

**Term Cable TF00164

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This Table Intended for 417A-11 Only

TABLE 5.6

417A UNIT PRELIMINARY ALIGNMENT (continued)

7A-11 ONLY / TEST	PCM GENERATOR: POWER	NOISE	MOD	PULSE	PERIOD	XMIT	FUNCTION	SYSTEM	CLOCK	ART. LINE	UNIT INTERFACE PANEL: BYPASS	BATTERY	SELECT	OSCILLOSCOPE	MONITOR	RPTR	TERM	417A INSTRUMENT SWITCHES: POWER	INTERLOCK	FORMAT	METER	P.E DET.	Power Loop CUR. ADJ.	Power Loop	TERM	RPTR	WELL: RPTR SUB. B	OUTPUT REQUIREMENTS: TEST POINT/S	DMM	417A METER	417A Indicator Lamp: LOW OUTPUT	PWR LOOP	FUSES	ERRORS	COMMENT
ALBO Alignment, Equalization	On	Off	Off	14	Norm	QRW* AMI	EURO	Remote Off	24*	Off	10*	B 30	N/A	Mon In	BI-1	FOR.	On	Out	AMI*	N/A	RPTR Out	N/A	B	Norm	BI-1	Side 1, RPTR 2 1	Note 3 Observe Scope Waveform	N/A	N/A	N/A	ON	N/A	N/A	Connect PCM line SIM. output to Inter. Panel Sim. Input via 310 cable, see Note 3.
ALBO Alignment Regenerated Clock					Stop Xmit	Bipolar pp	TIC																				Observe Counter Frequency Indication							See Note 4. Then adjust A2A-C34 for a counter indication of 2.048 MHz ±5.0KHz. Note that A2A-R77 pot. may be adjusted for a "trim" effect.
					Norm		Euro																											Remove short circuit jumper from A2A-TP3 to TP4, re-install the A2A Pwb into its well location with 417A power temporarily off; Then adjust A2A-R74 until the counter indicates "inlock" condition 2 048 MHZ ± 103HZ.
					Stop Xmit																													Counter freq. shifts away from 2.048MHz.
					Norm																													Verify InLock condition results 2.048 MHz ±103Hz. If not repeat the two previous test steps.
					Momentarily Stop Xmit						8																							
											12																						
Equalization Performance					Norm	QRW AMI			5		see comment											RPTR Input											Verify the specified 417A lamps status for Inter. Panel Battery voltage 12, 10, and 8 selections. See Note 5.
									9																		417A Lamps						
									16																								
									24																								
									31																								
									33																								
									36																								
					Xmit Errors																												Flash	
						QRW Coded														HDB3													
					Norm																												Off	

*anged from prior Test Table sheet switch setting.

Note 3: Connect scope to A2A-TP1 via X10 probe with its pigtail fastened to A2A-TP Gnd. Then adjust A2A-R26 for the most open "Eye Pattern" as illustrated.

Note 4: (1) Temporarily turn off the 417A power in order to place the 417A A2A (ALBO) PWB on an extender card in the 417A chassis.
(2) Connect the scope to A3-R25, left end (using X10 probe with its pigtail connected to the 417A chassis ground); set scope vertical gain to maximum.
(3) Connect BNC cable between the scope "vertical output jack" (on back of scope) to the counter input jack.
(4) Short circuit A2A-TP3 to TP4 with shortest possible jumper.
(5) Do not remove the A2A shields when calibrating or testing.

Note 5: Slight "trim" adjustment of A2A-R26 may be required to ensure specified ART LINE codes function with error free 417A Lamp Indication; however, "high level" equalization performance may be adversely compromised, consequently any "trim" adjustment of A2A-R26 must look for best "Eye Pattern" as illustrated.

ILLUSTRATION:

Open "Eye Pattern"

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This Table Intended for 417A-11 Only

TABLE 5.6

417A UNIT PRELIMINARY ALIGNMENT (continued)

ITEM	TEST	417A-11 ONLY	PCM GENERATOR									UNIT INTERFACE PANEL							417A INSTRUMENT SWITCHES									WELL	OUTPUT REQUIREMENTS						
			POWER	NOISE SIM	MOD	PULSE PERIOD	XMIT	FUNCTION	SYSTEM	DELAY	ART. LINE	BY-PASS	BATTERY	SELECT	OFFICE CURRENT	MONITOR	RPTR	TERM	POWER	INTERR LOCK	FORMAT	METER	P/E DET.	Power Loop CUR. ADJ.	Power Loop	TERM	RPTR	SUB. RPTR	TEST POINTS	DMM	417A METER	417A Indicator Lamp LOW OUTPUT	417A Indicator Lamp PWR LOOP	417A Indicator Lamp PULSES	417A Indicator Lamp ERRORS	COMMENTS
8.	Bridging; High Level Equalization		On	Off	Off	14	Norm with Boost	QRW Coded	EURO	Remote Off	N/A	Off	10*	8 30	N/A	Mon In	BI-1	FOR	On	Out	HDB3	N/A	Out	N/A	B	Norm	BI-1	Side 1, RPTR Z 11	417A Lamps	N/A	N/A	N/A	ON	ON	Off	Connect 010 cable between PCM GEN pulse GEN output and Inter. Panel Line Simulator Input Jacks. THEN Connect TERM cable, TF00163, between Inter. Panel and 417A 010 Bridging Jacks.
													8																						
													12																						
							Bipolar PP																												
													8																						
													12																						
9.	Signal Interlock						Norm						10																					Off	Remove TERM cable from Inter. Panel end ONLY

*Changed from prior Test Table sheet switch settings.

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6.0 HEAT RUN

6.1 Disconnect 417A from test set-up, and remove Substitute Repeater from repeater well.

6.2 Place instrument in oven as required by Quality Control Instruction No. 45.

6.3 Upon completion of burn-in period, remove instrument from oven and perform the Final Alignment per Section 7.0.

7.0 FINAL ALIGNMENT

7.1 Visual Inspection

7.1.1 Make a visual check for handling damage or mechanical failure due to Heat Run environment.

7.2 Equipment Warm-Up

7.2.1 All test equipment should be interconnected per Figure 9.1 and allowed a warm up of 30 minutes before starting test.

7.3 Test Set-Up

7.3.1 Prior to test and connection of the 417A to the Interface Panel, ensure the following conditions are met:

CAUTION: AVOID TOUCHING DMM CONNECTIONS OR PROBE CABLE PINS WHEN THE INTERFACE PANEL SELECT SWITCH IS SET to A 300 or B 300 POSITIONS.

7.3.1.1 Set the HP 895A Power Supply to 300V DC with the Interface Panel Select switch set to "A 300" as monitored by DMM, Subsequently set the Select switch to "CAL." position.

7.3.1.2 Install the Substitute Repeater into the 417A repeater well.

7.0 FINAL ALIGNMENT (continued)

7.4 Test Table

7.4.1 The 417A is to be tested and Final Aligned to Table 7.6 per "Input" setting for respective "Output" requirements.

7.4.2 Test Table input settings will remain unchanged from test to test/s unless otherwise specified by the Test Table for any given test.

7.4.3 Figure diagrams may be referred to in Section 9 as required thru-out testing.

7.4.4 The parenthesis symbol in the Test Table "(.....)" will distinguish the 417A-2 from the 417A-11. Always observe "comment" in Test Table.

7.5 417A Test Connection

7.5.1 Connect the 417A to the Interface Panel per Figure 9.1.

7.6 Test the 417A per the following table:

TABLE 7.6 417A UNIT FINAL ALIGNMENT

	PCM GENERATOR										UNIT INTERFACE PANEL								417A INSTRUMENT SWITCHES										WELL	OUTPUT REQUIREMENTS								
TEST	POWER	NOISE SIM	MOD	PULSE PERIOD	XMIT	FUNCTION	SYSTEM	DISABLE	ART. LINE	BY-PASS	BATTERY	SELECT	CURRENT OFFSET	MONITOR	RPTR	TERM	POWER	INTERLOCK	FORMAT	METER	P/E DET.	Power Loop CUR. ADJ.	Power Loop C & B	TERM	RPTR	SUB RPTR	TEST POINT/S	DMM	417A METER	417A Indicator Lamp LOW OUTPUT	417A Indicator Lamp PWR LOOP	417A Indicator Lamp PULSES	417A Indicator Lamp ERRORS	COMMENT
METER CIRCUITS ZERO	ON	OFF	OFF	14	NORM	ALL 1	T1 (Euro)	Remote OFF	24	OFF	12	A+	N/A	N/A	B1-1	DOM (For.)	OFF	OUT	1544 (AMI)	A ma NORM	RPTR INPUT	FULL CCW	OFF	NORM	B1-1	SIDE 1, RPTR Z1	417A METER	N/A	EXACTLY 0 vdc	OFF	OFF	OFF	OFF	Adj. 417A Meter Zero A/R
BATT																	BATT CHK.												Exactly 12 vdc	N/A		N/A	N/A	Adj. A4-R11 for 417A Meter = 12 vdc
WEST CURR													Adj. per DMM				ON											140 ma	140 ma (Same)					Adj. A4-R7 A/R for 417A Meter = DMM value
EAST CURR												B+								B ma NORM														Adj. A4-R9 A/R for 417A Meter = DMM value
RPTR VOLTS												CAL.	N/A							Rptr Volts (Side 1 Volts)						Fault Loc.		15.3 vdc ±0.05vdc	15.0 vdc Exactly					Adj. A4-R14 A/R for 417A Meter = 15.0 vdc.
POWER LOOP REGULATOR												A 30										Adj. per DMM	A			Side 1, RPTR Z1		30 ma thru 140 ma Current Range Span			ON			Verify PWR Loop Current Span by adjusting 417A Curr. Adj. Pot. on front panel
												A 300																						
LOW OUTPUT					↓							A+										N/A	OFF			Mon. Det. Key Out. Low	417A Lamps	N/A	N/A	ON	OFF	ON	OFF	Turn OFF HP895 Power Supply NOTE 1
NO DATA					STOP XMIT						↓															Release Out. Low				OFF		OFF		
417A-2 ONLY					NORM	QRW AMI	T1				10																417A Lamps	N/A	N/A		OFF	ON	OFF	NOTE 2
PULSE/ERROR DETECTOR					XMIT Errors	↓	↓												↓														Flash	
					↓	QRW Coded	J148												2370														↓	
					NORM	↓	↓																										OFF	
					↓	QRW AMI	TIC	After Lock ON											3152														↓	
					XMIT Errors	↓	↓	↓																										Flash	
					NORM	↓	↓	↓			↓	↓	↓			↓			↓			↓	↓										OFF	
417A-11 ONLY					NORM	QRW AMI	Euro	Remote OFF			10	A+				FOR.			AMI			N/A	OFF				417A Lamps	N/A	N/A		OFF	ON	OFF	
PULSE/ERROR DETECTOR					XMIT Errors	↓	↓	↓											↓														Flash	
					↓	QRW Coded													HD83														↓	
	↓	↓	↓	↓	NORM	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	OFF	

NOTE 1: Connect PCM PULSE GEN output to T.F. Line Sim. Input via 310 cable. If "Low Output" failure occurs, adjust 417A A2B-R30 pot. until the 417A "Low Output" Lamp just begins to extinguish when SUB RPTR "Low Output" switch is depressed; then back off TWO turn in the opposite direction such that the Lamp is solidly illuminated when SUB RPTR "Low Output" button is depressed. Verify Lamp extinguishes when said button is released. If "No Data" failure occurs, adjust 417A A2B-R22 for -40mvdc as indicated across TP2 (+ terminal) to TP 1 (- terminal) of said board WHILE "Stop Xmit" is depressed; then verify the 417A Pulses and Errors lamps DO NOT illuminate when "Stop Xmit" is depressed.

NOTE 2: If any 417A lamp indication should fail as specified, calibrate and/or verify the 417A A2A ALBO PWB per the Preliminary Alignment as follows:
If 417A unit under test is a 417A-2, revert to Preliminary Alignment sheets 11, 12 this test procedure.
If 417A unit under test is a 417A-11, revert to Preliminary Alignment sheets 13, 14 this test procedure.
Then verify said ALBO performance as specified per Item 5 of this FINAL ALIGNMENT sheet.

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SCALE	STOCK AS	SHEET 17

8.0 PRODUCT ACCPETANCE TEST

8.1 Visual Inspection

8.1.1 Inspect the 417A instrument under test for proper overall fit and finish workmanship.

8.1.2 Verify the 417A knobs have proper index registrations.

8.2 Equipment Warm-Up

8.2.1 All test equipment should be interconnected per Figure 9.1 and allowed a 30 minute warm-up prior to testing.

8.3 Test Set-Up

8.3.1 Prior to test and connection of the 417A to the Interface Panel, ensure the following conditions are met:

CAUTION: AVOID TOUCHING DMM CONNECTIONS OR PROBE CABLE PINS WHEN THE INTERFACE PANEL SELECT SWITCH IS SET TO A 300 or B 300.

8.3.1.1 Set the HP 895A Power Supply to 300V DC with the Interface Panel Select switch set to "A 300" as monitored by DMM. Subsequently set the "Select" switch to "CAL." position.

8.3.1.2 Install fresh batteries into the 417A, and fasten the 417A cover. (Remove batteries subsequent to Test Table completion.)

8.3.1.3 Ensure that the Substitute Repeater is installed into the 417A repeater well.

8.4 Test Table

8.4.1 The 417A is to be product acceptance tested to Table 8.6 per "Input" settings for respective "Output" requirements.

8.4.2 Test Table settings will remain unchanged from test to test/s unless otherwise specified by the Test Table for any given test.

8.4.3 An asterick (*) will indicate switch setting changes from preceeding to succeeding test table sheets. Always observe "comment" in Test Table.

8.4.4 Figure diagrams may be referred to in Section 9 as required thru-out testing.

8.0 PRODUCT ACCEPTANCE TEST (continued)

8.5 417A Test Connection

8.5.1 Connect the 417A to the Test Fixture per Figure 9.1 EXCEPT for "battery" power as the 417A is to be tested with its proper complement of batteries. Fasten the 417A cover.

8.6 Test the 417A per the following table:

TABLE 8.6 417A UNIT PRODUCT ACCEPTANCE TEST

ITEM	TEST	STEP	PCM GENERATOR: POWER	NOISE	SIM	MOD	PULSE	PERIOD	XMIT	FUNCTION	SYSTEM	DISABLE	ART. LINE	UNIT INTERFACE PANEL: BY-PASS	BATTERY	SELECT	OFFICE CURRENT	MONITOR	RPTR	TERM	417A INSTRUMENT SWITCHES: POWER	INTERLOCK	FORMAT	METER	P/E DET.	Power Loop CUR. ADJ.	Power Loop	TERM	RPTR	WELL SUB. RPTR	OUTPUT REQUIREMENTS: TEST POINT/S	DMM	417A METER	417A Indicator Lamp: LOW OUTPUT	PWR LOOP	PULSES	ERRORS	COMMENT
1	METER CIRCUITS	BATTERY	1	ON	OFF	OFF	14		NORM	ALL	TI (Euro)	Remote OFF	5	OFF	N/A	A+	N/A	N/A	B1-1	DOM (For.)	OFF	OUT	1544 (AMI)	A ma NORM			OFF	NORM	B1-1	SIDE 1, RPTR Z1	417A METER	N/A	040.1 vdc	OFF	OFF	OFF	OFF	N/A
			2																		BATT CHK.											Within Green Zone, ±0.5 vdc	N/A		N/A	N/A	Verify 417A PWR ON Lamp is Illuminated
		WEST CURR	3														Adj. per DMM				ON											30 ma	30 ma ±5 ma					Verify 417A Meter Performance by adjusting Inter. Panel "Office Curr" to specified DMM value.
			4																													140 ma	140 ma ±5 ma					
			5													A-								A ma REV.														
		EAST	6													B+								B ma NORM														
			7													B-								B ma REV.														
		RPTR VOLTS	8													CAL.	N/A							RPTR Volts (Side1 Volts)							Fault Loc.		N/A	15.0 vdc ±0.5 vdc					N/A
			9													Thrs.															Side 1, RPTR Z1		20 vdc	0 vdc ±0.5 vdc					
			10													A 30											Adj. per DMM	A					140 ma	10.5 vdc ±0.5 vdc		ON			Adjust 417A PWR Loop Pot for 10mA indicated value
	-11 Only		11													(B 30)								(Side 2 Volts)				(B)			Side 1, RPTR Z2)								417A-11 Only
2	POWER LOOP REGULATOR		1													A 30								A ma NORM				A			Side 1 RPTR Z1		30 ma thru 140 ma Current Range Span.						Verify 417A Power Loop by varying the 417A Curr. Adj. Pot. thru the specified range.
			2													A 300																						
			3													B 30								B ma NORM				B										
			4													B 300																						
3	PULSE ERROR PERFORMANCE		1													A+		MON IN						A ma NORM			N/A	OFF				SCOPE: 432 vpp Required for each test step	N/A	N/A	OFF	OFF	ON	OFF	Connect PCM PULSE GEN. output to Inter. Panel Line Sim. Input. Waveform Polarity may change. Turn OFF HP895 Power Supply
			2																										Side 1								
			3																										Both								
			4																B1-2											B1-2								
			5																										Side 2								
			6																										NORM								
			7																UNI-1											UNI-1								
			8																UNI-2											UNI-2								
			9																										Side 2								
			10																										Both								
			11																											Side 2				ON				NOTE 1

NOTE 1: Momentarily depress the SUB. RPTR. "OUTPUT LOW" Button, and verify 417A Low Output Lamp Illuminates only when depressed.

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54778	A	A03191400
SCALE	STOCK AS	SHEET 20

TABLE 8.8 417A UNIT PRODUCT ACCEPTANCE TEST (Continued)

ITEM	TEST	STEP	PCM GENERATOR: POWER	NOISE	SIM	MOD	PULSE	PERIOD	XMIT	LOOP	SYSTEM	PSAFE	ART. LINE	UNIT INTERFACE PANEL: BYPASS	BATTERY	SELECT	OFFICE CURRENT	MONITOR	REPEATER	TERM	417A INSTRUMENT SWITCHES: POWER	INTERLOCK	FORMAT	METER	P/E DET.	Power Lamp CUR. ADJ.	Power Lamp	TERM	RPTR	WELL SUBUNIT	OUTPUT REQUIREMENTS: TEST POINT/S	DMM	417A METER	417A Indicator Lamp LOW OUTPUT	PWR LOOP	PULSES	ERRORS	COMMENTS
4	417A-2 PULSE/ERROR DETECTOR & Equalization	1	ON	OFF	OFF		14		NORM	QRW AMI	T1*	Remote OFF	5	OFF	N/A	A+	N/A	N/A	UNI-2	DOM	ON	OUT	1544	A ma NORM	RPTR IN	N/A	OFF	NORM	UNI-2	SIDE 1, RPTR Z1	417A LAMPS	N/A	N/A	N/A	OFF	ON	OFF	Connect PCM Line Sim. output to Inter. Panel Line Sim. Input via 310 Cable
		2							XMIT Errors																												Flash	
		3							NORM				16																								OFF	
	T1:	4											33																									
		5											36																									
		6							XMIT Errors																												Flash	
		7								QRW Coded	T148		33										2370														
	T148:	8							NORM																												OFF	
		9											16																									
		10											9																									
		11											5																									
		12							XMIT Errors																												Flash	
		13								QRW AMI	T1C	After Lock ON											3152														
		14							NORM																												OFF	
	T1C:	15											24																									
		16											36																									
		17											40																									
		18							XMIT Errors																												Flash	
	Bridging: See Note 2	19							NORM	QRW Coded	T148	Remote OFF	N/A										2370		RPTR Out											OFF	Connect 310 Cable between Bridging Inter. Panel 310 Jack and 417A Bridging Input Jack (Use Term Cable TF00164)
	High Level Equalization:	20							NORM/ Boost																													
		21								Bipolar PP	T1												1544																
5	NO SIGNAL, 417A-2	1							Stop XMIT																												OFF	
		2																																				Remove 310 Bridging Cable

* Changed from prior Test Table switch settings.

NOTE 2: Connect a 310 to 310 cable between the PCM GEN Pulse Gen Output jack and Interface Panel Line Sim. Input jack.

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54778	A	A03191400
SCALE	STOCK AS	SHEET 21

TABLE B.6 417A UNIT PRODUCT ACCEPTANCE TEST (Continued)

	TEST	STEP	PCM GENERATOR: POWER	NOISE	SIM	MOD	PULSE	PER CD	XMIT	FUNCTION	SYSTEM	ENABLE	ART. LINE	UNIT INTERFACE PANEL: BYPASS	BATTERY	SELECT	OFF CUR.	MON	RPTR	TERM	417A TEST EQUIPMENT SWITCHES: POWER	INTERLOCK	FORMAT	METER	P/E DET.	Power Loop CUR. ADJ.	Power Loop	TERM	RPTR	WE: SUB b, R	OUTPUT REQUIREMENTS: TEST POINTS	DMM	417A METER	417A Bridging Loop: LOW OUTPUT	PWR LOOP	PULSES	ERRORS	COMMENT
6	417A-11 PULSE/ERROR DETECTOR & Equalization	1	ON	OFF	OFF		14		NORM	QRW AMI	EURO	Remote OFF	5	OFF	N/A	N/A	N/A	MON IN	UNI-2	FOR	ON	OUT	AMI	A ma NORM	RPTR IN	N/A	OFF	NORM	UNI-2	SIDE 1, RPTR Z1	417A LAMPS	N/A	N/A	N/A	OFF	ON	OFF	Connect PCM Line Sim. output to Inter. Panel Line Sim. Input via cable.
		2							XMIT Errors																												Flash	
		3							NORM				24																								OFF	
	AMI:	4											31																									
		5											36																									
		6							XMIT Errors																												Flash	
		7								QRW Coded													HDB3															
		8							NORM																												OFF	
	HDB3:	9											31																									
		10											24																									
		11											5																									
		12							XMIT Errors																												Flash	
	Bridging: See Note 2	13							NORM				N/A													RPTR Out										OFF	Connect Cable between Inter. Panel Bridging 310 Jack and 417A Bridging Input Jack. (Use Term. Cable TF00163)
	High Level Equalization	14							NORM/ Boost																													
		15								Bipolar PP													AMI															
7	NO SIGNAL, 417A-11	1							Stop XMIT																												OFF	
		2																																				Remove 310 Bridging Cable

*Changed from Test Table sheet #20 switch settings

NOTE 2: Connect a 310 to 310 cable between the PCM GEN Pulse Gen Output Jack and Interface Panel Line Sim. Input Jack.

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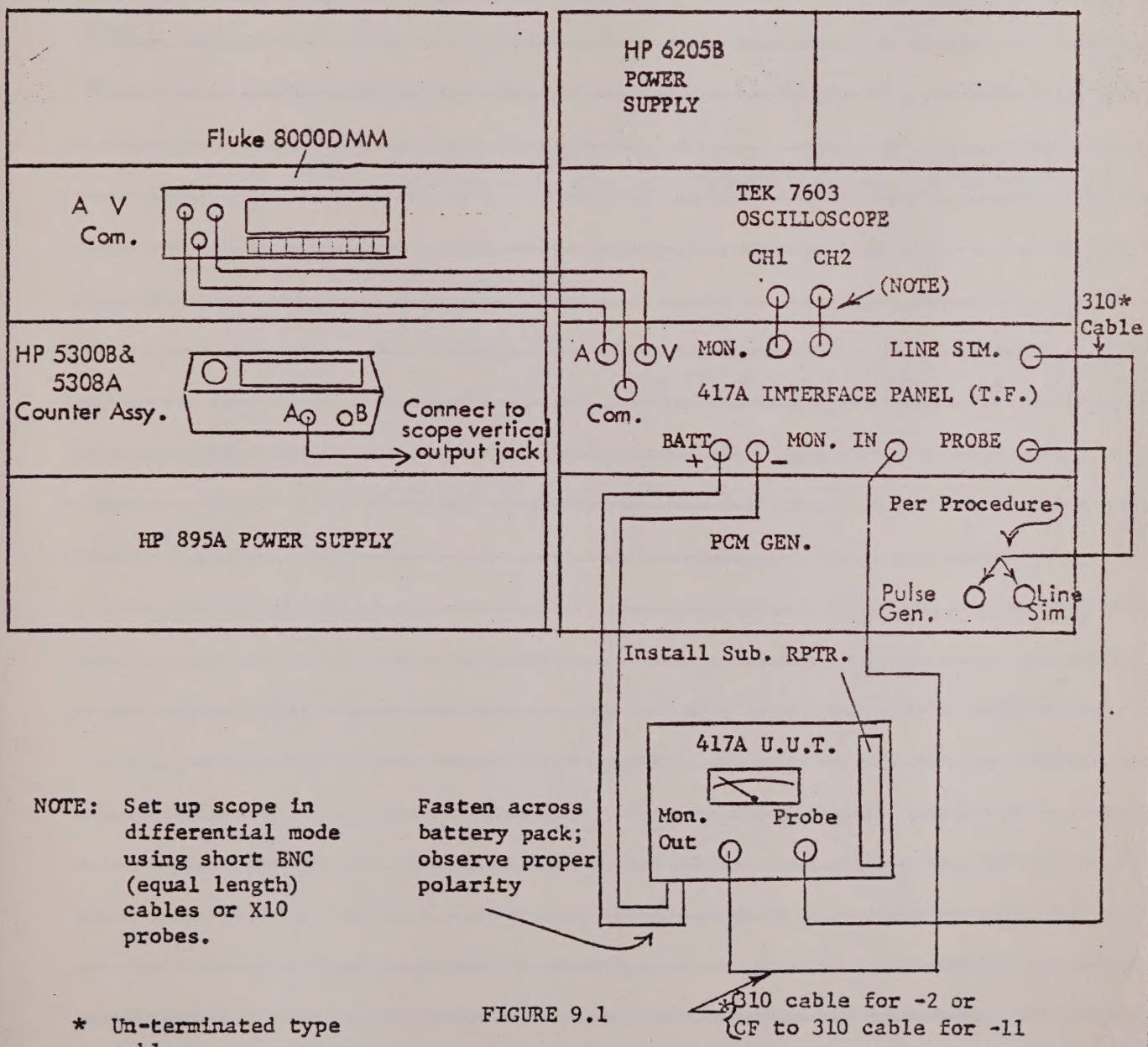
S4778	A	A03191400
SCALE	STOCK AS	SHEET 22

417A TEST EQUIPMENT INTERCONNECT



NOTE: Set up scope in differential mode using short BNC (equal length) cables or X10 probes.

* Un-terminated type cables.

FIGURE 9.1

CODE IDENT NO.	SIZE	DRAWING NO.
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SCALE		SHEET 23 of 23

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